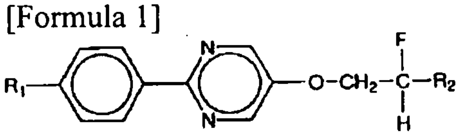
* NOTICES *

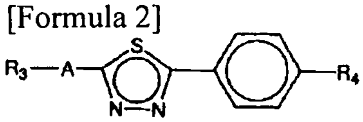
CLAIMS

[Claim(s)]
[Claim 1] General formula (I)
[Formula 1]



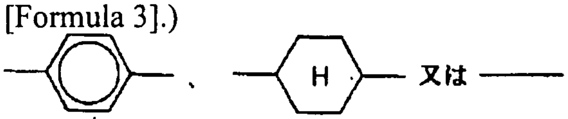
(I)

It is [at least one sort and] the following general formula (II) about the compound expressed with (R1 shows the alkyl group of carbon numbers 4-16 among a formula, and R2 shows the alkyl group of carbon numbers 2-12, respectively).
[Formula 2]

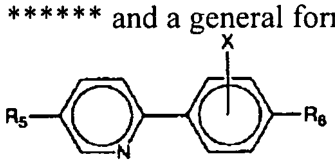


(II)

(R3 and R4 show the alkyl group or alkoxy group of carbon numbers 1-15 among a formula, and A is [Formula 3].)



****** and a general formula (III) -- [Formula 4]



(III)

It is the ferroelectric liquid crystal constituent characterized by containing at a time at least one sort of compounds expressed with (R5 and R6 show the alkyl group or alkoxy group of carbon numbers 1-18 among a formula, and X shows a hydrogen atom, one piece, or two fluorine atoms).
[Claim 2] The ferroelectric liquid crystal constituent according to claim 1 with which the compound of a general formula (I) is contained in a constituent at 30 or less % of the weight of a rate.
[Claim 3] The ferroelectric liquid crystal constituent according to claim 1 or 2 with which the compound of a general formula (II) and the compound of a general formula (III) are contained in a constituent by the weight ratio of 40-90:60-10.
[Claim 4] furthermore, claims 1-3 which are the compounds with which at least one sort of optically active compounds are contained, and this optically active compound produces the compound of a general formula (I), and the spiral of the opposite sense within a cholesteric phase -- the ferroelectric liquid crystal constituent of any one publication.
[Claim 5] The ferroelectric liquid crystal constituent of any one publication of claim 1-4 which a

ferroelectric liquid crystal constituent shows the phase transition sequence of an isotropic liquid phase, cholesteric phase, smectic A phase, and chiral smectic C phase from an elevated-temperature side.
[Claim 6] The ferroelectric liquid crystal constituent of any one publication of claim 1-5 whose absolute value of deltaepsilon a ferroelectric liquid crystal constituent shows negative dielectric constant anisotropy deltaepsilon, and is two or more.
[Claim 7] The ferroelectric liquid crystal component characterized by including the ferroelectric liquid crystal constituent of any one publication of claim 1-6.
[Claim 8] The ferroelectric liquid crystal component according to claim 7 in which it has at least the insulating substrate of a pair with which the ferroelectric liquid crystal component was equipped with an electrode and the orientation control film in this order, and the liquid crystal layer formed between orientation control film, and a liquid crystal layer contains a ferroelectric liquid crystal constituent.
[Claim 9] A liquid crystal layer shows smectic layer structure, and the bending direction of this smectic layer structure and the direction of the pre tilt of a liquid crystal molecule are the same ferroelectric liquid crystal component according to claim 8.
[Claim 10] The ferroelectric liquid crystal component according to claim 9 whose pre tilt angle of a liquid crystal molecule is 10 degrees or less.
[Claim 11] The ferroelectric liquid crystal component of any one publication of claim 7-10 in which a ferroelectric liquid crystal constituent shows a cholesteric phase and a chiral smectic C phase, has a cholesteric pitch with a liquid-crystal-thickness Mino [of a ferroelectric liquid crystal component] of 0.5 or more times in a cholesteric phase, and has a chiral smectic C pitch more than the thickness of a liquid crystal layer in a chiral smectic C phase.
[Claim 12] The liquid crystal layer which it had between the insulating substrate of the pair equipped with an electrode and the orientation control film in this order, and the insulating substrate of this pair, The driving means which switches the optical axis of liquid crystal by impressing an electrical potential difference to said electrode alternatively, Have a means to identify the change of said optical axis optically, and said liquid crystal layer consists of a ferroelectric liquid crystal constituent in which at least two stable states of any one publication of claim 1-7 are shown. Said electrode consists of two or more scan electrodes and two or more signal electrodes, and it arranges in the direction in which a scan electrode and a signal electrode cross mutually. The ferroelectric liquid crystal component which makes a pixel the field where this scan electrode and this signal electrode crossed The 1st pulse voltage V1 is followed to the pixel chosen as arbitration, and they are the 2nd pulse voltage V2 or the 1st pulse voltage. - V1 is followed and it is the 2nd pulse voltage. - V2 is impressed. The ferroelectric liquid crystal molecule contained in the ferroelectric liquid crystal constituent which constitutes said selected pixel is made into one certain stable state of at least two stable states. Subsequently The 1st pulse voltage V3 is followed to said selected pixel, and they are the 2nd pulse voltage V4 or the 1st pulse voltage. - V3 is followed and it is the 2nd pulse voltage. - V4 is impressed. The drive approach of the ferroelectric liquid crystal display device characterized by driving by holding the stable state of said ferroelectric liquid crystal molecule (however, electrical potential differences V1, V2, V3, and V4 having the relation between $0<V2<V4$ and $V2-V1<V4-V3$).
[Claim 13] The drive approach of a ferroelectric liquid crystal component according to claim 12 that a ferroelectric liquid crystal constituent has two stable states, rewriting to the stable state of another side from one stable state is performed by the unipolar pulse, the pulse width-pulse voltage characteristic at the time of this unipolar-pulse impression has the minimum value, and this minimum value is less than [60V].
[Claim 14] The drive approach of a ferroelectric liquid crystal component according to claim 13 that the minimum value is characterized by being less than [35V].

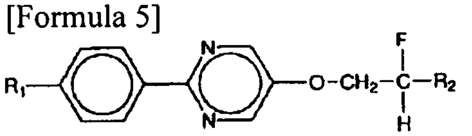
[Translation done.]

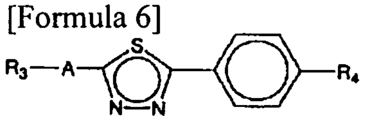
* NOTICES *

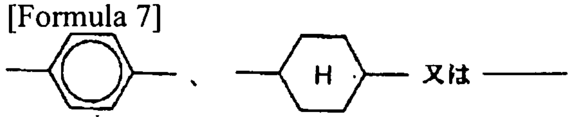
DETAILED DESCRIPTION

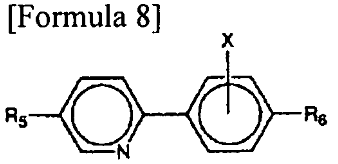
[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a ferroelectric liquid crystal constituent, a ferroelectric liquid crystal component, and its drive approach. Furthermore, this invention relates to a ferroelectric liquid crystal constituent with the large temperature dependence of spontaneous polarization, the ferroelectric liquid crystal component using it, and the detailed drive approach.
[0002]
[Description of the Prior Art] The liquid crystal constituent is widely used as a display device ingredient. Depending most current liquid crystal display components on TN mold means of displaying, this means of displaying uses the nematic phase of a liquid crystal constituent. TN mold means of displaying used for the liquid crystal display component is roughly divided into two. One is the active matrix which attached the switching element in each pixel which constitutes a liquid crystal display component. As an example of this method, what used the thin film transistor (TFT:Thin Film Transistor) as a driver element is known. The display grace of the component by this method is attained to the level which equals CRT (Cathode Ray Tube). However, enlargement of a screen is difficult and cost's is high.
[0003] Another is a STN (Super Twisted Nematic) method. Although contrast and a viewing-angle dependency are improved compared with the conventional passive matrix, display grace is not given to the level of CRT. However, a manufacturing cost is low. Considering the grace and a manufacturing cost, these two methods have merits and demerits. As a method which was expected to solve these two persons' trouble and appeared, the means of displaying which used the ferroelectric liquid crystal (FLC) is held. Now, when it is only called FLC, a surface passivation ferroelectric liquid crystal (SSFLC) is shown. This SSFLC will be N.A. Clerks and S.T. Lagerwall {applied physics in 1980. It was proposed by Letters (899 Appl.Phys.Lett.36, 1980) reference}. Since then, it is called next-generation liquid crystal, and commercial production is tackled and amelioration and commercialization of a display property have been performed by the home electronics maker and the ingredient manufacturer.
[0004] The ferroelectric liquid crystal component has the following description (1) high-speed responsibility (2) memory nature (3) wide-field-of-view angles theoretically. The above-mentioned description has suggested possibility that SSFLC can be used to a mass display, and makes SSFLC very attractive.
[0005] However, the problem which must be solved as research progresses has been clarified. One of the technical problems important also in it is the manifestation by which memory was stabilized. Generating of the internal field reversing considered that the cause with difficult making memory discover stably originates in that smectic layer structure is not uniform (for example, a torsion array, Chevron structure) and spontaneous polarization being too large etc. is mentioned.
[0006] The approach using the ferroelectric liquid crystal constituent which has a negative dielectric constant anisotropy (it is hereafter called deltaepsilon for short) as one of the means for making the stable memory nature discover is proposed {the Paris RIKUIDDO crystal conference (Paris Liquid Crystal Conference) and p.217 (1984) reference}. This approach is called the AC stubbies rise

effectiveness. In the cel to which deltaepsilon carried out homogeneous orientation processing of the negative liquid crystal molecule, when electric field are perpendicularly impressed to an electrode, there is a property to turn to an parallel condition (for a molecule major axis to be perpendicular to the direction of electric field) to a glass substrate. When low frequency electric field are impressed, in order that spontaneous polarization may answer electric field, if the direction of electric field is reversed, in connection with it, a liquid crystal molecule also moves to another stable state, and will be in an parallel condition to a substrate there by the effectiveness of deltaepsilon. When RF electric field are impressed, even if it becomes impossible for spontaneous polarization to follow in footsteps of reversal of electric field, only deltaepsilon is effective and it reverses the direction of electric field, migration of a liquid crystal molecule does not break out, but becomes parallel to a substrate as it is. This is the manifestation mechanism of the memory nature using the AC stubbies rise effectiveness. High contrast can be acquired and the example is already reported by this {refer to SID'85 digest p.128 (1985)}.
[0007] Moreover, "the method of using the liquid crystal ingredient which has a negative dielectric anisotropy" is independently proposed by P.W.H.Surguy etc. (ferro erection RIKUSU (Ferroelectrics), and {122, 63, 1991}). This technique is promising technique in order to realize high contrast. The ferroelectric liquid crystal display using this technique is indicated by Proc.SID and 217 (1992) by P.W.Ross. Hereafter, this ferroelectric liquid crystal display is stated to a detail.
[0008] In the case of the usual ferroelectric liquid crystal ingredient whose dielectric anisotropy is not negative, tau (pulse width required in order to carry out memory) falls in monotone as an electrical potential difference (V) becomes high. On the other hand, in the case of the ferroelectric liquid crystal ingredient which has a negative dielectric anisotropy, the tau-V property which shows the minimal value (tau-Vmin) is acquired. Surguy etc. has reported the JOERS/Alvey driving method as a driving method which used this property. When it impresses the electrical potential difference of |Vs-Vd|, it is made SUINNGU [the memory condition of a ferroelectric liquid crystal component], and the principle of this driving method is an approach of not making it switch, when |Vs+Vd| which is an electrical potential difference higher than this electrical potential difference is impressed, and when |Vd| lower than this electrical potential difference is impressed.
[0009] Since the ferroelectric liquid crystal ingredient of a negative dielectric anisotropy is applicable to the display device using the AC stubbies rise effectiveness and taumin as mentioned above, it hides possibility that it can use for utilization of a ferroelectric liquid crystal component.
[0010]
[Problem(s) to be Solved by the Invention] One of the important technical problems of other which SSFLC holds is that the optical response is very sensitive to temperature. In the case of TN mold means of displaying, the desired amount of transmitted lights has been obtained by the interaction of the dielectric anisotropy of a liquid crystal molecule, and electric field. Therefore, the amount of transmitted lights obtained is mostly determined with the dielectric constant and applied voltage of a liquid crystal molecule, and viscosity influences only the part of a transient optical response.
[0011] On the other hand, in SSFLC, it has spontaneous polarization Ps, and it is changing the amount of transmitted lights by switching the stable state of a liquid crystal molecule by driving force Ps-E by it and electric field E. The speed of response tau at this time is tau** (eta/Ps-E) in approximation.... It will become a formula 1 and will be directly influenced of the rotation viscosity eta. Furthermore, since this rotation viscosity changes a lot to temperature, as for a speed of response tau, it becomes easy to be influenced of temperature. That is, in order to obtain the desired amount of transmitted lights using a transient optical response according to a formula 1 unlike TN mold means of displaying, in SSFLC, it will be directly influenced of viscosity, and it will be sensitive to temperature.
[0012] This technical problem is concerned with the principle of operation of SSFLC. That is, it is very difficult to make the speed of response of SSFLC independent to viscosity. It is also very difficult to make temperature dependence of viscosity small on the other hand. Therefore, in order to realize a component with more small temperature dependence, Factors Ps, i.e., the spontaneous polarization, or electric fields E other than the viscosity eta of a formula 1 must be changed corresponding to the viscosity change by temperature.

[0013] It is comparatively easy to change electric field E with temperature. However, it will become a cost rise -- IC driver with high withstand voltage with which a circuit becomes complicated is needed. Moreover, if the constituent in which spontaneous polarization Ps has the big temperature dependence according to viscosity change is used even when such a change function of electric field E to temperature is added to a component, it is possible to lessen a cost rise. That is, using the big constituent of such temperature dependence of Ps has the advantage which raises the engine performance of the liquid crystal device containing it.
[0014]
[Means for Solving the Problem] Therefore, the purpose of this invention has the temperature dependence of spontaneous polarization Ps in offering offering a big ferroelectric liquid crystal constituent, the liquid crystal device using this ferroelectric liquid crystal constituent, and its drive approach. According to this invention in this way, it is a general formula (I).
[0015]
[Formula 5]

(I)

[0016] It is [at least one sort and] the following general formula (II) about the ferroelectric liquid crystal compound in which at least two stable states expressed with (R1 shows the alkyl group of carbon numbers 4-16 among a formula, and R2 shows the alkyl group of carbon numbers 2-12, respectively) are shown.
[0017]
[Formula 6]

(II)

[0018] (R3 and R4 show the alkyl group or alkoxy group of carbon numbers 1-15 among a formula, and A is [0019].)
[Formula 7]


[0020] ****** and a general formula (III) [0021]
[Formula 8]

(III)

[0022] The ferroelectric liquid crystal constituent characterized by containing at a time at least one sort of compounds made to express with (R5 and R6 show the alkyl group or alkoxy group of carbon numbers 1-18 among a formula, and X shows a hydrogen atom, one piece, or two fluorine atoms) is offered. Furthermore, according to this invention, it is the ferroelectric liquid crystal component which has at least the insulating substrate of the pair equipped with an electrode and the orientation control film in this order, and the liquid crystal layer formed between orientation control film, and the ferroelectric liquid crystal component characterized by a liquid crystal layer containing the above-mentioned ferroelectric liquid crystal constituent is offered.
[0023] Moreover, the insulating substrate of the pair which was equipped with an electrode and the orientation control film in this order according to this invention, The liquid crystal layer which it had between the insulating substrates of this pair, and the driving means which switches the optical axis of

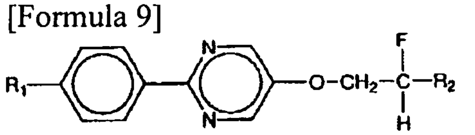
liquid crystal by impressing an electrical potential difference to said electrode alternatively, It consists of a ferroelectric liquid crystal constituent containing the ferroelectric liquid crystal molecule which has two stable states even if few. a means to identify the change of said optical axis optically -- having -- said liquid crystal layer -- the above -- Said electrode consists of two or more scan electrodes and two or more signal electrodes, and it arranges in the direction in which a scan electrode and a signal electrode cross mutually. The ferroelectric liquid crystal component which makes a pixel the field where this scan electrode and this signal electrode crossed The 1st pulse voltage V1 is followed to the pixel chosen as arbitration, and they are the 2nd pulse voltage V2 or the 1st pulse voltage. - V1 is followed and it is the 2nd pulse voltage. - V2 is impressed. The ferroelectric liquid crystal molecule contained in the ferroelectric liquid crystal constituent which constitutes said selected pixel is made into one certain stable state of at least two stable states. Subsequently The 1st pulse voltage V3 is followed to said selected pixel, and they are the 2nd pulse voltage V4 or the 1st pulse voltage. - V3 is followed and it is the 2nd pulse voltage. - V4 is impressed. The drive approach of the ferroelectric liquid crystal display device characterized by driving by holding the stable state of said ferroelectric liquid crystal molecule (however, electrical potential differences V1, V2, V3, and V4 having the relation between $0<V2<V4$ and $V2-V1<V4-V3$) is offered.

[0024]

[The mode of implementation of invention] The ferroelectric liquid crystal constituent of this invention is a general formula (I).

[0025]

[Formula 9]



(I)

[0026] At least one sort of ferroelectric liquid crystal compounds expressed with (R1 shows the alkyl group of carbon numbers 4-16 among a formula, and R2 shows the alkyl group of carbon numbers 2-12, respectively) are contained. The compound of a general formula (I) can use each of compound which can use each well-known compound, for example, is indicated by JP,63-190842,A and JP,5-239460,A, and its process for this invention.

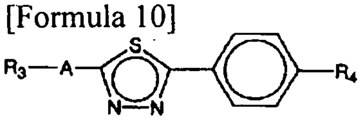
[0027] R1 As an alkyl group of carbon numbers 4-16, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, and hexadecyl, methyl, and ethyl, in a side chain is mentioned during a definition. R2 As an alkyl group of carbon numbers 2-12, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, and dodecyl, methyl, and ethyl, in a side chain is mentioned during a definition.

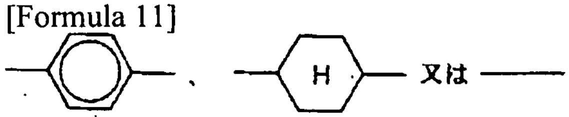
[0028] R1 If it carries out, carbon numbers 6-9 are desirable, and it is R2. If it carries out, carbon numbers 6-8 are desirable. More desirable R1 R2 As a combination, hexyl, hexyl, heptyl and hexyl, octyl and hexyl, nonyl and hexyl, hexyl, octyl, heptyl and octyl, and nonyl and octyl are mentioned. the above -- desirable R1 R2 The phase transition temperature of the compound which it has is shown in Table 1.

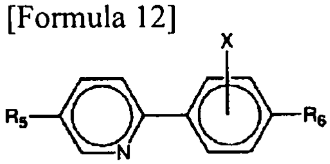
[0029]

[Table 1]

化合物番号	R 1	R 2	Cr	SF*	SC*	SA	I
I－1	C_6H_{13}－	C_6H_{13}－	· 48.6		· 53.0	· 78.4	·
I－2	C_7H_{15}－	C_6H_{13}－	· 52.0		· 54.5	· 80.5	·
I－3	C_8H_{17}－	C_6H_{13}－	· 46.2		(· 45.0)	· 80.0	·
I－4	C_9H_{19}－	C_6H_{13}－	· 43.6		· 45	· 81.3	·
I－5	C_6H_{13}－	C_8H_{17}－	· 74.3		· 77.0	· 83.6	·
I－6	C_7H_{15}－	C_8H_{17}－	· 70.5	(· 59.5)	· 79.4	· 85.4	·
I－7	C_8H_{17}－	C_8H_{17}－	· 63.5	(· 58.3)	· 76.3	· 84.0	·
I－8	C_9H_{19}－	C_8H_{17}－	· 60.8	(· 57.4)	· 79.2	· 85.2	·

[0030] In Table 1, the figure expresses phase transition temperature with the Celsius degree, and Cr, SF*, SC*, and SA and I mean each phase of a crystal, chiral smectic one F, chiral smectic one C, smectic A, and an isotropic liquid, respectively. - The mark means that the phase outlined on it exists, and the figure in a parenthesis means that phase transition is monotropy nature.
[0031] Here, the following points are mentioned as a description of the compound of a general formula (I).
(1) The absolute value of spontaneous polarization Ps is large.
(2) The sign of spontaneous polarization changes with temperature.
(3) The temperature from which Ps sign changes is higher than 25 degrees C.
The ferroelectric liquid crystal constituent of this invention is the following general formula (II) as components other than the compound of a general formula (I).
[0032]
[Formula 10]

(II)

[0033] (R3 and R4 show the alkyl group or alkoxy group of carbon numbers 1-15 among a formula, and A is [0034].)
[Formula 11]


[0035] ****** and a general formula (III) [0036]
[Formula 12]

(III)

[0037] Kind content of the compound expressed with (R5 and R6 show the alkyl group or alkoxy group of carbon numbers 1-18 among a formula, and X shows a hydrogen atom, one piece, or two fluorine atoms) is carried out at least. General formula (II) And (III) can use each compound with a well-known compound. R3 And R4 As an alkyl group of carbon numbers 1-15, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, dodecyl, tridecyl, tetradecyl, and pentadecyl, methyl, and ethyl, in a side chain is mentioned during a definition.
[0038] R3 And R4 As an alkoxy group of carbon numbers 1-15, the branching-like alkoxy group which

has low-grade alkyl groups, such as a straight chain-like alkoxy group of methoxy and ethoxy ** propoxy, butoxy one, pentoxy, hexyloxy one, heptyloxy, octyloxy, nonyloxy, decyloxy one, undecyloxy, dodecyloxy, tridecyl oxy-** tetra-decyloxy, and PENTADESHIRUOKISHI, methyl, and ethyl, in a side chain is mentioned during a definition.
[0039] R3 If it carries out, the alkyl group or alkoxy group of carbon numbers 3-10 is desirable, and as R4, the alkyl group of carbon numbers 2-8 is desirable. More desirable R3 And R4 As a combination, hexyl, pentyl and octyl, ethyl and butyl, hexyl and butyl, octyl and pentyl, heptyl and pentyl, heptyl and hexyl, octyl and hexyl, pentyl, octyloxy, pentyl and decyloxy one, pentyl and butyl, heptyl and pentyl, and octyl are mentioned.
[0040] Especially desirable A and R3 And R4 As for combination, 1 and 4-cyclo hexylene, hexyl, pentyl, 1, and 4-cyclo hexylene, hexyl, octyl and p-phenylene, octyl, ethyl and p-phenylene, butyl, hexyl and p-phenylene, butyl, heptyl and p-phenylene, butyl, octyl and p-phenylene, pentyl, heptyl and p-phenylene, pentyl, octyl, and p-phenylene, hexyl and octyl are mentioned.
[0041] R5 And R6 As an alkyl group of carbon numbers 1-18, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, dodecyl, undecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl, methyl, and ethyl, in a side chain is mentioned during a definition.
[0042] R5 And R6 As an alkoxy group of carbon numbers 1-18, the branching-like alkoxy group which has low-grade alkyl groups, such as a straight chain-like alkoxy group of methoxy and ethoxy ** propoxy, butoxy one, pentoxy, hexyloxy one, heptyloxy, octyloxy, nonyloxy, decyloxy one, undecyloxy, dodecyloxy, tridecyl oxy-** tetra-decyloxy, pentadecyl oxy-** hexa decyloxy, hepta-decyloxy, and octadecyloxy, methyl, and ethyl, in a side chain is mentioned during a definition.
[0043] R5 If it carries out, the alkyl group of carbon numbers 6-10 is desirable, and it is R6. If it carries out, the alkoxy group of carbon numbers 4-15 is desirable. More desirable X and R5 And R6 As a combination, a hydrogen atom, heptyl, pentoxy and a hydrogen atom, heptyl, hexyloxy one, a hydrogen atom, octyl, hexyloxy one, etc. are mentioned.
[0044] The blending ratio of coal in the constituent of the above-mentioned general formula (I) - (III) is as following. The orientation rate of the compound of a general formula (I) is 0.5 - 30 % of the weight preferably 0.5 to 60% of the weight in a constituent. In addition, the mixed rate is indicated that the phenomenon in which the sign of spontaneous polarization changes is no longer observed by above-mentioned JP,63-190842,A and JP,5-239460,A at less than 60 % of the weight. In this invention, the following descriptions of (4) were newly found out as a description of the compound of a general formula (I) here in addition to (1) - (3). Furthermore, this description found out that it was discovered even if a mixed rate is less than 60 % of the weight.
(4) The temperature dependence of spontaneous polarization is large.
[0045] Therefore, it can control effectively that the amount of transmitted lights changes with fluctuation of temperature by using the compound of a general formula (I). What is necessary is on the other hand, just to contain in the constituent at least one sort of compounds which general formula (II) Reach (III). In addition, as for both of compounds which general formula (II) Reach (III), containing in the constituent is desirable, and it is more desirable to be contained in a constituent by the weight ratio of 40-90:60-10.
[0046] Here, the ferroelectric liquid crystal constituent of this invention has the following advantageous matters.
(1) A physical-properties value [weight / phase transition temperature / dielectric anisotropy deltaepsilon, viscosity eta, a phase sequence,] is controllable by components other than a compound (I).

(2) Since the pitch in a cholesteric phase becomes short in proportion to the mixed rate of the compound of a general formula (I), if a mixed rate is low, a pitch will become long and its homogeneity stacking tendency in the case of using as SSFLC will improve.
(3) If the mixed rate of the compound of a general formula (I) of spontaneous polarization Ps is high, it will become large. Generally big Ps has the large anti-electric field induction is carried out [electric

field] by the reversal, and the so-called seizure phenomenon becomes severe.
[0047] Therefore, from above-mentioned (1) - (3), the mixed rate of the compound of a general formula (I) of the ferroelectric liquid crystal constituent of this invention is low, and since it has comparatively small Ps, a good ferroelectric liquid crystal component with few printing phenomena can be offered. Furthermore, as for the ferroelectric liquid crystal constituent of this invention, it is desirable that the phase transition sequence is an isotropic liquid phase [from an elevated-temperature side], cholesteric phase, smectic A phase, and chiral smectic C phase. This is because uniform orientation is easy to be obtained in a nematic phase, the orientation which had complete set of direction of the normal of a smectic phase will be obtained easily and a uniform switching characteristic and high contrast will be acquired, if the temperature is lowered from the condition to a smectic A phase and chiral smectic C phase.
[0048] Moreover, it is desirable that deltaepsilon of a constituent is [the absolute value] two or more in negative. When deltaepsilon is forward, since pulse width (tau) falls in monotone as an electrical potential difference (V) becomes high, it is not desirable. Furthermore, when an absolute value is less than two, since it will become a high voltage too much if it is going to obtain a required speed of response, and a speed of response will become slow too much if it is going to lower an electrical potential difference, it is not desirable.
[0049] Furthermore, as for the ferroelectric liquid crystal constituent of this invention, it is desirable to contain at least one sort of optically active compounds whose sense of the spiral produced within a cholesteric phase is opposite sense of the compound of a general formula (I). Thereby, the pitch within a cholesteric phase is compensated and orientation homogeneity improves. Moreover, if the orientation in a cholesteric phase improves, the orientation in a smectic phase will also improve and a uniform switching characteristic and high contrast will be acquired.
[0050] According to this invention, the ferroelectric liquid crystal component which contains the above-mentioned ferroelectric liquid crystal constituent in a liquid crystal layer is also offered. The ferroelectric liquid crystal component of this invention has at least the insulating substrate of the pair equipped with an electrode and the orientation control film in this order, and the liquid crystal layer formed between orientation control film. As an insulating substrate, each thing usually used in the field concerned can be used, for example, glass, plastics, etc. are mentioned.
[0051] the electrode on an insulating substrate -- from metal electrodes, such as transparent electrodes, such as InO3, SnO2, and ITO (Indium-TinOxide), and aluminum, Cu, etc. -- becoming -- CVD (Chemical Vapor Deposition) -- it is formed in a predetermined pattern by law or the spatter. The thickness of an electrode has desirable 50-200nm. The orientation control film is formed on an electrode. The film of an inorganic system or an organic system can be used for the orientation control film. Silicon oxide etc. is mentioned as orientation control film of an inorganic system. Although a well-known approach can be used for the membrane formation approach, slanting vacuum deposition, rotation vacuum deposition, etc. can be used, for example. As orientation control film of an organic system, nylon, polyvinyl alcohol, polyimide, etc. are mentioned and rubbing of the front face of the orientation control film is usually carried out. moreover -- the case where a polymer liquid crystal and LB (Langmuir Blodgett) film are used -- a magnetic field -- or orientation may be carried out by the spacer edge method. Moreover, SiO2, SiNx, etc. may be formed with vacuum deposition, a spatter, a CVD method, etc., and orientation may be carried out by carrying out rubbing of the it top. The thickness of the orientation control film has desirable 10-100nm. In addition, the following of the concrete orientation approach is carried out.
[0052] The insulating film may be made to intervene between an electrode and the orientation control film here. the insulating film -- for example, SiO2, SiNx, aluminum 2O3, and Ta 2O5 etc. -- organic system thin films, such as an inorganic system thin film, polyimide, photoresist resin, and a polymer liquid crystal, can be used. When the insulating film is an inorganic system, it can form by vacuum deposition, the spatter, the CVD method, the solution applying method, etc. moreover, the approach of applying using the solution which melted the organic substance, or its precursor solution by the spinner applying method, the dip painting cloth method, screen printing, a roll coating method, etc. in the case

of an organic system, making harden on predetermined hardening conditions (heating, optical exposure, etc.), and forming or vacuum deposition, a spatter, a CVD method, and LB -- it can also form by law etc. 50-200nm of thickness of the thickness of the insulating film is desirable.

[0053] A ferroelectric liquid crystal component is obtained by pouring a ferroelectric liquid crystal constituent into the space between lamination and the orientation control film for the insulating substrate with which the insulating film was formed in the above-mentioned electrode, the orientation control film, and arbitration through a sealing compound etc., and forming a liquid crystal layer. In addition, the above-mentioned ferroelectric liquid crystal component may be equipped with the polarizing plate as the driving means which changes the optical axis of liquid crystal, and a means to identify the change of said optical axis optically, by impressing an electrical potential difference to the above-mentioned electrode alternatively further.

[0054] The example of the ferroelectric liquid crystal component of this invention is shown in drawing 1 . The transparent insulating substrate (glass substrate) of the pair which has the electrodes 3 and 4 of the predetermined pattern with which 1 and 2 consist of conductive film, the liquid crystal layer between which it is placed between sealing compounds by the orientation control film and 7, and 8 made the insulating film and 6 placed by 5 between the insulating substrate 1 and 2, and 9 show a polarizing plate among drawing 1 . In addition, the driving means which changes the optical axis of liquid crystal is not illustrated by impressing an electrical potential difference to an electrode alternatively.

[0055] As mentioned above, although explained as a switching element with one pixel in drawing 1 , the ferroelectric liquid crystal component of this invention is applicable to the display of a mass matrix. As a display means of a matrix, as shown in the top view of drawing 2 , the approach of using combining the electrodes 3 and 4 of the vertical insulation substrates 1 and 2 the shape of a matrix is mentioned. Each intersection of electrodes 3 and 4 is equivalent to 1 pixel among drawing.

[0056] Drawing 3 is drawing for explaining C1 orientation and C2 orientation in the liquid crystal device of drawing 2 . Here, as an orientation art of the orientation control film which constitutes the ferroelectric liquid crystal component of this invention, the rubbing method is desirable. There are mainly approaches, such as parallel rubbing, antiparallel rubbing, and piece rubbing, in the rubbing method. parallel rubbing -- the vertical orientation control film -- rubbing -- carrying out -- the direction of rubbing -- abbreviation -- it is the parallel rubbing method. Antiparallel rubbing carries out rubbing of the vertical orientation control film, and is the rubbing method the direction of rubbing is substantially antiparallel. Piece rubbing is the approach of carrying out rubbing only of the orientation control film of one side among vertical orientation control film. The most desirable method of obtaining uniform orientation in this invention is the approach of combining the cel processed by parallel rubbing, and the ferroelectric liquid crystal which has an INAC phase sequence. In this case, in a nematic phase, uniform orientation is easy to be obtained, and if the temperature is lowered, the orientation to a smectic A phase and chiral smectic C phase which had complete set of direction of a layer normal will be easily obtained from that condition. However, in the liquid crystal device of parallel rubbing, the number of the orientation conditions produced in a chiral smectic C phase is never one. There are two causes which do not become homogeneity extensively.

[0057] One is related with a smectic layer bending. Although it is known well that the layer structure (Chevron layer structure) to which the ferroelectric liquid crystal cel bent is shown, as shown in drawing 3 , two fields may exist. Kannabe etc. has named these C1 and C2 from relation with a pre tilt. Another is a uniform (U) and the twist (T). The orientation where a uniform shows an extinction position, and the twist are orientation which does not show an extinction position. Kouden etc. has reported that three orientation, C1U (C1 uniform), C1T (C1 twist), and C2, was obtained in the ferroelectric liquid crystal cel of parallel rubbing which used the high pre tilt orientation control film (Jpn.J.Appl.Phys., 30, L1823 (1991)).

[0058] this invention person etc. checked that C1U, C1T, C2U, and four orientation conditions of C2T existed in the ferroelectric liquid crystal cel by which parallel rubbing processing of the orientation control film was carried out, as a result of inquiring in a detail further. The molecular orientation of these orientation conditions is shown in drawing 4 . When compared about four orientation conditions

acquired in the ferroelectric liquid crystal cel which has a negative dielectric anisotropy, since it was hard to switch C1U and C1T orientation, they were difficult to drive, and since there was no extinction position, it turned out that good contrast will not be acquired even if it switches in C1T orientation. On the other hand, it turned out that C2U orientation gives a good switching characteristic and contrast. Moreover, in order that C2T orientation might show quenching nature like uniform orientation at the time of impression of moderate bias electric field when a liquid crystal ingredient has a negative dielectric anisotropy although it does not show quenching nature at the time of no electric-field impressing, this invention person etc. found out that a good SUICHINGU property and contrast were acquired even in C2T orientation.

[0059] Although the appearance nature of C1 and C2 orientation is related to a pre tilt, C2 condition may occur in the range whose pre tilt angle is 0-15 degrees. Although there is only C2 condition of only one condition which shows an extinction position as Kouden etc. has reported when a pre tilt angle is large, this is desirable rather. However, since there is an inclination which becomes easy to turn into C1 orientation from C2 orientation with the increment in a pre tilt angle, a pre tilt angle has desirable 10 degrees or less.

[0060] Next, in this invention, the drive approach of the above-mentioned ferroelectric liquid crystal component is also offered. Hereafter, the drive approach is described. the drive wave shown in drawing 5 as the drive approach, for example -- the JOERS/Alvey driving method by (A), and a drive wave as shown in drawing 6 -- the driving method by (B) is mentioned. These driving methods are the driving methods which can perform partial rewriting, and are desirable methods of driving the ferroelectric liquid crystal component of large display capacity, such as 2000x2000 etc. lines.

[0061] a drive wave -- the wave when not rewriting, although the voltage waveform concerning a pixel is expressed in (B) by (a) - (d) -- tau when the electrical potential difference of (b) and (d) is impressed is equal, and since the amount of transmitted lights is almost equal, the good display without a flicker is obtained. moreover, the drive wave shown in drawing 7 -- the drive wave using the Maine pulse part which is not 0V of 0V part of one time slot, and one time slot as the malvern driving method (the [International Patent Publication] WO 92/02925) which makes (C) an example is shown in drawing 8 -- it is the driving method into which the Maine pulse width was changed by the die length of arbitration to the JOERS/Alvey driving method by (A). Since this driving method can pile up the timing which impresses an electrical potential difference by inter-electrode and can make the Rhine address time small, it is one of the desirable driving methods.

[0062] The method of driving the ferroelectric liquid crystal ingredient of this invention for having the tau-V property which shows the minimal value by pulse width tau including the above-mentioned driving method is characterized at the following points. The method of driving this invention follows the pixel on the selected scan electrode at the 1st pulse voltage V1, and is the 2nd pulse voltage V2 or the 1st pulse voltage. - V1 is followed and it is the 2nd pulse voltage. - By impressing V2, a ferroelectric liquid crystal molecule is not twisted to the stable state before electrical-potential-difference impression, but is made into one stable state with the polarity of applied voltage. Subsequently, the same pixel is followed at the 1st pulse voltage V3, and they are the 2nd pulse voltage V4 or the 1st pulse voltage. - V3 is followed and it is the 2nd pulse voltage. - If V4 is impressed, it will be the driving method for holding the stable state of the ferroelectric liquid crystal molecule before electrical-potential-difference impression. Furthermore, electrical potential differences V1-V4 set to satisfy following type 0<V2<V4V2-V1<V4-V3 to one of the descriptions.

[0063] That is, in two time slots of the selection period beginning, the voltage waveform applied to maintenance has the 2nd pulse voltage higher than the wave applied to rewriting, and a voltage waveform is set up so that the electrical-potential-difference difference of the 1st pulse and the 2nd pulse may become large. Such electrical potential differences V1, V2, V3, and V4 for example, in drive wave (A) of drawing 5 At drive wave (B) of V1=Vd, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd drawing 6 , it becomes V1=Vd, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd by drive wave (C) of V1=0, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd drawing 7 .

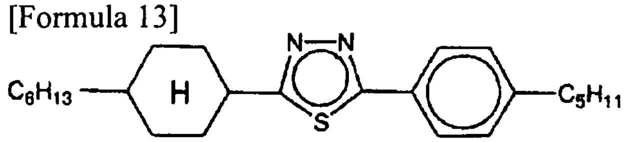
[0064] It sets in the tau-V property of a liquid crystal device, and is minimal value taumin of pulse width

tau. Electrical potential difference Vmin to give It is directly related to the maximum of the electrical potential difference impressed at the time of a drive. The pressure-proofing of a drive circuit used for a drive to Vmin It is Vmin in order to use less than [60V] and the drive circuit using general-purpose IC driver. The ferroelectric liquid crystal constituent which is less than [35V] is needed. Moreover, it sets to the drive of a ferroelectric liquid crystal component whose pulse width tau has the tau-V property which shows the minimal value. By for example, the approach of embellishing component structure like a cel gap or an electrode configuration Use as a wave which applies to maintenance the wave applied to rewriting of the specific part in a pixel by making to arbitration the field where drive properties differ in a pixel in other parts in the same pixel, or It is possible to use as a wave which applies the wave applied to maintenance of the specific part in a pixel to rewriting in other parts in the same pixel. Therefore, a gradation display can also be performed.
[0065] In addition, in explanation of this invention, although parallel rubbing, C2 orientation, the method of driving a property, etc. were described as an example of the directions of very desirable this invention, of course, it cannot be overemphasized that this invention is not limited to this and can apply also to a liquid crystal display another type and the driving method. Next, taumin of this invention The applicability to the used liquid crystal display component is explained. The following formulas are realized by the simple system which assumed layer structure to be book-shelf structure {liquid coulisse TARUZU 6, No.3, and p341 (1989) reference}.
[0066]
[Equation 1]

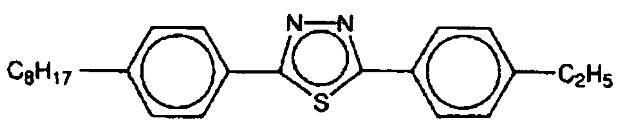
$$E\min = \frac{Ps}{3^{1/2} \cdot \varepsilon_0 \cdot \Delta\varepsilon \cdot \sin^2\theta}$$

[0067] (Among a formula, in spontaneous polarization and epsilon 0, the dielectric constant of vacuum and deltaepsilon show a dielectric constant anisotropy, and theta shows [an electrical potential difference / in / in Emin / the pulse width of the minimal value /, and Ps] an angle of inclination) Electrical potential difference practical from this formula, for example, Emin, When making it less than [40V], and 20 degrees and deltaepsilon are the liquid crystal constituents of -two and theta uses a 2-micrometer cel, spontaneous polarization is 7 nC/cm2. It must be the following {ferro erection RIKUSU 122nd volume p63 (1991) reference}. Although it is inapplicable as it is since actual layer structure has many which are the Chevron structure, it can use as estimate. It is Emin that this formula shows, so that delta epsilon and theta are so large that Ps is small. It is being able to do low. The pulse width (taumin) of the minimal value is in inverse proportion to the square of spontaneous polarization {ferro erection RIKUSU 122nd volume p63 (1991) reference}. That is, taumin In order to shorten, it is necessary to enlarge spontaneous polarization Ps. if it thinks together with the above-mentioned formula -- Emin low -- for example, less than [40V] -- carrying out -- in addition -- and taumin In order to shorten and to perform a high-speed drive, deltaepsilon needs to have a negative big value. Conversely, it will be Emin if the liquid crystal constituent in which deltaepsilon has a negative big value if it says is used. Even if it sets up low, large Ps is taken, and it is taumin. It can do short. Said compound (II) and compound (III) in this invention are a compound which has big deltaepsilon in negative. Therefore, taumin Application for the used liquid crystal display component is very effective.
[0068] As mentioned above, taumin Although stated focusing on application for the used liquid crystal display component, this invention relates to the manifestation of the big temperature dependence of the spontaneous polarization Ps by the new constituent, and the component using it. That is, the ferroelectric liquid crystal constituent of this invention is taumin a passage clearer than this. Or it is not only adapted for the component using the AC stubbies rise effectiveness, but it can use for the usual SSFLC component.
[0069]
[Example] Although an example explains this invention further below at a detail, this invention is not limited to these examples. Measurement of each physical-properties value in this example was performed by the following approach.

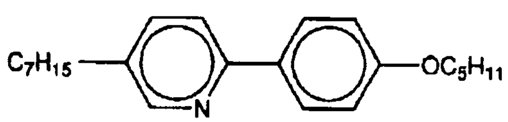
Phase transition temperature (degree C): The observation under the polarization microscope which attached the hot stage for temperature control determined. The melting point was measured using differential scan calorimetric analysis (DSC). In the following examples, phase transition temperature (degree C) was indicated between the abridged notations which show a phase. Notations Cr, SX, SC, SA, N, and Iso mean each phase of a crystal, a high order smectic phase, a smectic C phase, a smectic A phase, a nematic phase, and an isotropic liquid, respectively.
[0070] Spontaneous polarization (nC/cm2): The class product was injected into the cel whose electrode spacing which performed orientation processing is 1.5 micrometers, and the polarization reversal current peak was taken out from the current response waveform when impressing a square wave (**15V and 1kHz), and it determined from the area.
A tau-V property, Vmin, taumin : Using the ferroelectric liquid crystal component created by the below-mentioned approach, without impressing bias voltage, two unipolar pulses, forward and negative, were impressed by turns, and it measured by switching domain observation under a polarization microscope. The peak value (V) of this unipolar pulse was changed, by asking for the pulse width (tau) which a domain reverses 100% with each peak value, the tau-V curve was obtained and the peak value (Vmin) in that minimal value and pulse width (taumin) were obtained from this tau-V curve.
[0071] As preparation which produces a ferroelectric liquid crystal constituent, the non-chiral constituent (non-ferroelectricity constituent) as shown below first was produced.
Constituent (a)
[0072]
[Formula 13]



35 wt%

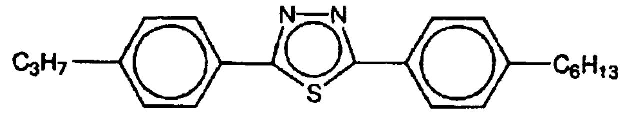


15 wt%



50 wt%

[0073] The phase transition temperature of this constituent is Cr. -31 degrees C SX -10 degrees C SC 72.8 degrees C SA 85.8 degrees C N 98.1 degrees C It was Iso.
Constituent (b) : [0074]
[Formula 14]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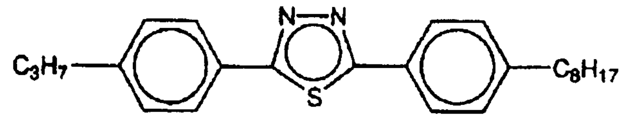
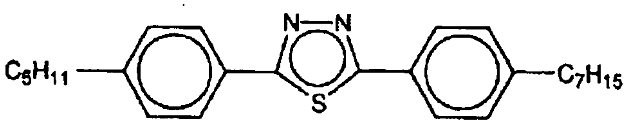

12.5重量%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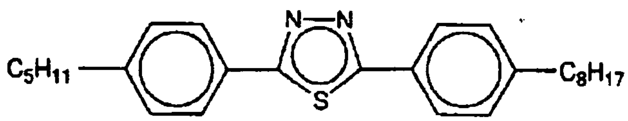
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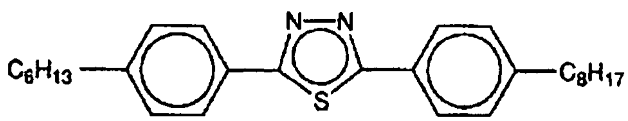
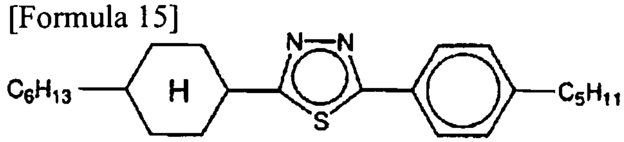
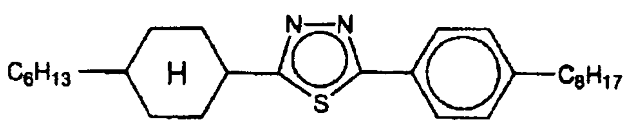
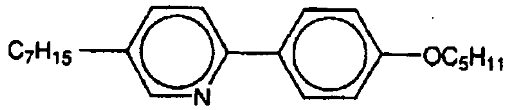

25重量%

[0075] The phase transition temperature of this constituent is Cr. 43 degrees C SC 126.0 degrees C N 154.4 degrees C It was Iso.
Constituent (c) : [0076]
[Formula 15]


70重量%


30重量%

[0077] The phase transition temperature of this constituent is Cr. 29 degrees C SA 143.7 degrees C N 144.1 degrees C It was Iso.
Constituent (d) : [0078]
[Formula 16]



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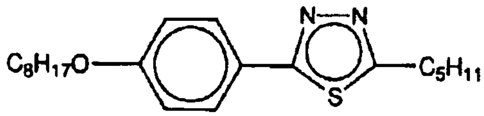
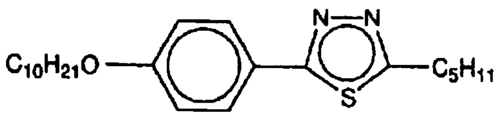
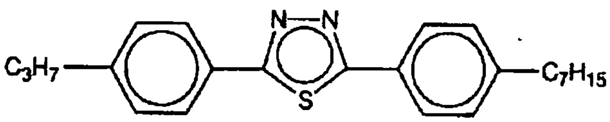


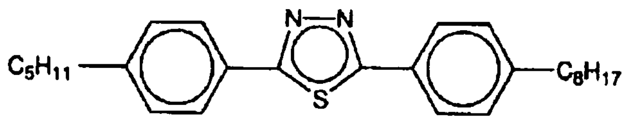
15■■%



20■■%



25■■%

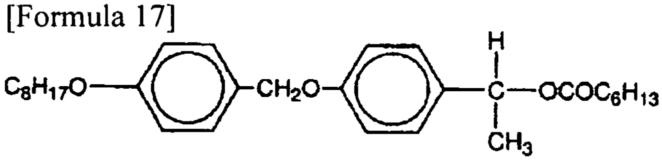


20■■%

[0079] The phase transition temperature of this constituent is Cr. -4 degrees C SC 86.5 degrees C SA 96.8 degrees C N 101.8 degrees C It was Iso.
Constituent (e): Constituent (a) 75-% of the weight constituent (b) 10-% of the weight constituent (c) The phase transition temperature of this constituent is SC 15% of the weight. 74.5 degrees C SA 93.8 degrees C N 107.5 degrees C It was Iso.
[0080] Moreover, in each example, the ferroelectric liquid crystal component was obtained using the approach shown below. That is, the transparent electrode which consists of 200nm ITO was formed on two glass substrates. this transparent electrode top -- 100nm SiO2 from -- the becoming insulator layer was formed, the orientation control film was applied by 50nm of thickness on this insulator layer, and rubbing processing was performed. Next, these two glass substrates were stuck by 1.5 micrometers (gap) of cel thickness so that the direction of rubbing might become parallel. Subsequently, the ferroelectric liquid crystal constituent produced in each example was poured into this gap. The cel was heated after impregnation to the temperature from which a liquid crystal constituent once changes to an isotropic liquid, and the ferroelectric liquid crystal component whose orientation of a liquid crystal molecule is C2 all over the inside of a pixel was obtained by cooling to a room temperature by part for 1-degree-C/after that.
[0081] In the following examples, the compound used as a component of a liquid crystal constituent was displayed with said compound number.
The example 1 aforementioned compound (I-1) and the constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (f) was adjusted.
Compound (I-1) 10-% of the weight constituent (e) ******** of the 90-% of the weight above-mentioned constituent (f) is SC. 57 degrees C SA 94 degrees C N It was 103degree-CI. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 9 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0082] The example 2 aforementioned compound (I-3) and the constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (g) was adjusted.
Compound (I-3) 10-% of the weight constituent (e) The phase transition temperature of the 90-% of the weight above-mentioned constituent (g) is SC. 60 degrees C SA 93 degrees C N 103 degrees C It was I.

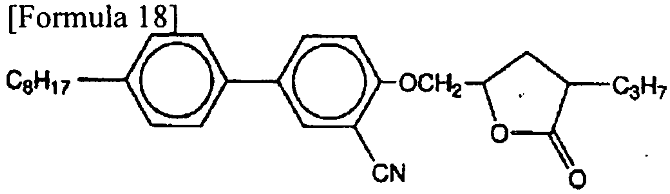
Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 10 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0083] The example 3 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (h) was adjusted.
Compound (I-1) 2.5-% of the weight compound (I-2) 2.5-% of the weight compound (I-3) 2.5-% of the weight compound (I-4) 2.5-% of the weight constituent (e) The phase transition temperature of the 90-% of the weight above-mentioned constituent (h) is SC. 59 degrees C SA 93 degrees C N 102 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 11 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0084] The example 4 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (i) was adjusted.
Compound (I-1) 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (e) The phase transition temperature of the 95-% of the weight above-mentioned constituent (i) is SC. 65 degrees C SA 93 degrees C N 104 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 12 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.

[0085] The example 5 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (d) were mixed at following rate, and the ferroelectric liquid crystal constituent (j) was adjusted.
Compound (I-1) 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (d) The phase transition temperature of the 95-% of the weight above-mentioned constituent (j) is SC. 81 degrees C SA 95 degrees C N 100 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 13 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.

[0086] The example 6 aforementioned compound (I-1), (I-2), (I-3), (I-4), a constituent (a), (b), and (c) were mixed at following rate, and the ferroelectric liquid crystal constituent (j) was adjusted.
It was compound (I-1) I. 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (a) 57-% of the weight constituent (b) 19-% of the weight constituent (c) The phase transition temperature of the 19-% of the weight above-mentioned constituent (j) is SC. 73 degrees C SA 99 degrees C N 111 degrees C Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 14 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0087] Similarly to the pneumatic liquid crystal compound PYP605 by example 7 Merck Co., the optically active compound R-811 by Merck Co. and S-811 were added respectively, and a liquid crystal constituent (l) and (m) were produced to it. It turns out that the sense of the cholesteric pitch of R-811 and S-811 is R (+) and L (-), respectively. A compound (I-1) and (I-3) were independently added to PYP605, respectively, a liquid crystal constituent (n) and (o) were produced, and the sense of a compound (I-1) and each cholesteric pitch of (I-3) was measured by the contacting method using the above-mentioned constituent (l) and (m). Consequently, a compound (I-1) and (I-3) were found by that it is L (-).
[0088] The optically active compound with which it turns out that the sense of an example 8 cholesteric pitch is R (+) (C-1)
[0089]
[Formula 17]


[0090] Said compound (I-1) and constituent (e) were mixed at following rate, and the strong dielectric

forward liquid crystal constituent (p) was prepared.
Compound (C-1) 4-% of the weight compound (I-1) 8-% of the weight constituent (e) The phase transition temperature of the 88-% of the weight above-mentioned constituent (p) is SC. 50 degrees C SA 90 degrees C N It was 98degree-CI. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 15 . Spontaneous polarization ps showed big temperature dependency so that more clearly than drawing.
[0091] Temperature was changed and the tau-V property of the liquid crystal constituent (i) of example 9 example 4 was measured. Pulse width taumin in the minimal value Temperature dependence is shown in drawing 16 . A passage clearer than drawing, it compares with the liquid crystal constituent (q) of the example 2 of the after-mentioned comparison, and is taumin. Temperature dependence became small.
[0092] Example of comparison 1 optically active compound (C-2)
[0093]
[Formula 18]



[0094] Said constituent (e) was mixed at following rate, and the ferroelectric liquid crystal constituent (q) was adjusted.
Compound (C-2) 2.5-% of the weight constituent (e) The phase transition temperature of the 97.5-% of the weight above-mentioned constituent (q) is SC. 66 degrees C SA 92 degrees C N 104 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 17 . Drawing shows that the value is saturated with the low temperature side and especially the temperature dependence of the spontaneous polarization of the above-mentioned liquid crystal constituent (q) is small.
[0095] Temperature was changed and the tau-V property of the liquid crystal constituent (q) of the example 1 of example of comparison 2 comparison was measured. Pulse width taumin in the minimal value Temperature dependence is shown in drawing 16 . A passage clearer than drawing, it compares with the liquid crystal constituent (i) of an example 9, and is taumin. Temperature became large. By this invention, the temperature dependence of spontaneous polarization Ps is large, and can obtain the small ferroelectric liquid crystal component of the temperature dependence of a speed of response as the above example and the example of a comparison show.
[0096]
[Effect of the Invention] The ferroelectric liquid crystal constituent offered by this invention shows temperature dependence with the big temperature dependence of the spontaneous polarization Ps. The liquid crystal device using this constituent can show temperature dependence with that small speed of response, and can obtain a large temperature margin at the time of practical use.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to a ferroelectric liquid crystal constituent, a ferroelectric liquid crystal component, and its drive approach. Furthermore, this invention relates to a ferroelectric liquid crystal constituent with the large temperature dependence of spontaneous polarization, the ferroelectric liquid crystal component using it, and the detailed drive approach.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] The liquid crystal constituent is widely used as a display device ingredient. Depending most current liquid crystal display components on TN mold means of displaying, this means of displaying uses the nematic phase of a liquid crystal constituent. TN mold means of displaying used for the liquid crystal display component is roughly divided into two. One is the active matrix which attached the switching element in each pixel which constitutes a liquid crystal display component. As an example of this method, what used the thin film transistor (TFT:Thin Film Transistor) as a driver element is known. The display grace of the component by this method is attained to the level which equals CRT (Cathode Ray Tube). However, enlargement of a screen is difficult and cost's is high.
[0003] Another is a STN (Super Twisted Nematic) method. Although contrast and a viewing-angle dependency are improved compared with the conventional passive matrix, display grace is not given to the level of CRT. However, a manufacturing cost is low. Considering the grace and a manufacturing cost, these two methods have merits and demerits. As a method which was expected to solve these two persons' trouble and appeared, the means of displaying which used the ferroelectric liquid crystal (FLC) is held. Now, when it is only called FLC, a surface passivation ferroelectric liquid crystal (SSFLC) is shown. This SSFLC will be N.A. Clerks and S.T. Lagerwall {applied physics in 1980. It was proposed by Letters (899 Appl.Phys.Lett.36, 1980) reference}. Since then, it is called next-generation liquid crystal, and commercial production is tackled and amelioration and commercialization of a display property have been performed by the home electronics maker and the ingredient manufacturer.
[0004] The ferroelectric liquid crystal component has the following description (1) high-speed responsibility (2) memory nature (3) wide-field-of-view angles theoretically. The above-mentioned description has suggested possibility that SSFLC can be used to a mass display, and makes SSFLC very attractive.
[0005] However, the problem which must be solved as research progresses has been clarified. One of the technical problems important also in it is the manifestation by which memory was stabilized. Generating of the internal field reversing considered that the cause with difficult making memory discover stably originates in that smectic layer structure is not uniform (for example, a torsion array, Chevron structure) and spontaneous polarization being too large etc. is mentioned.
[0006] The approach using the ferroelectric liquid crystal constituent which has a negative dielectric constant anisotropy (it is hereafter called deltaepsilon for short) as one of the means for making the stable memory nature discover is proposed {the Paris RIKUIDDO crystal conference (Paris Liquid Crystal Conference) and p.217 (1984) reference}. This approach is called the AC stubbies rise effectiveness. In the cel to which deltaepsilon carried out homogeneous orientation processing of the negative liquid crystal molecule, when electric field are perpendicularly impressed to an electrode, there is a property to turn to an parallel condition (for a molecule major axis to be perpendicular to the direction of electric field) to a glass substrate. When low frequency electric field are impressed, in order that spontaneous polarization may answer electric field, if the direction of electric field is reversed, in connection with it, a liquid crystal molecule also moves to another stable state, and will be in an parallel condition to a substrate there by the effectiveness of deltaepsilon. When RF electric field are impressed,

even if it becomes impossible for spontaneous polarization to follow in footsteps of reversal of electric field, only deltaepsilon is effective and it reverses the direction of electric field, migration of a liquid crystal molecule does not break out, but becomes parallel to a substrate as it is. This is the manifestation mechanism of the memory nature using the AC stubbies rise effectiveness. High contrast can be acquired and the example is already reported by this {refer to SID'85 digest p.128 (1985)}.
[0007] Moreover, "the method of using the liquid crystal ingredient which has a negative dielectric anisotropy" is independently proposed by P.W.H.Surguy etc. (ferro erection RIKUSU (Ferroelectrics), and {122, 63, 1991}). This technique is promising technique in order to realize high contrast. The ferroelectric liquid crystal display using this technique is indicated by Proc.SID and 217 (1992) by P.W.Ross. Hereafter, this ferroelectric liquid crystal display is stated to a detail.
[0008] In the case of the usual ferroelectric liquid crystal ingredient whose dielectric anisotropy is not negative, tau (pulse width required in order to carry out memory) falls in monotone as an electrical potential difference (V) becomes high. On the other hand, in the case of the ferroelectric liquid crystal ingredient which has a negative dielectric anisotropy, the tau-V property which shows the minimal value (tau-Vmin) is acquired. Surguy etc. has reported the JOERS/Alvey driving method as a driving method which used this property. When it impresses the electrical potential difference of |Vs-Vd|, it is made SUINNGU [the memory condition of a ferroelectric liquid crystal component], and the principle of this driving method is an approach of not making it switch, when |Vs+Vd| which is an electrical potential difference higher than this electrical potential difference is impressed, and when |Vd| lower than this electrical potential difference is impressed.
[0009] Since the ferroelectric liquid crystal ingredient of a negative dielectric anisotropy is applicable to the display device using the AC stubbies rise effectiveness and taumin as mentioned above, it hides possibility that it can use for utilization of a ferroelectric liquid crystal component.
[0010]

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The ferroelectric liquid crystal constituent offered by this invention shows temperature dependence with the big temperature dependence of the spontaneous polarization Ps. The liquid crystal device using this constituent can show temperature dependence with that small speed of response, and can obtain a large temperature margin at the time of practical use.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] One of the important technical problems of other which SSFLC holds is that the optical response is very sensitive to temperature. In the case of TN mold means of displaying, the desired amount of transmitted lights has been obtained by the interaction of the dielectric anisotropy of a liquid crystal molecule, and electric field. Therefore, the amount of transmitted lights obtained is mostly determined with the dielectric constant and applied voltage of a liquid crystal molecule, and viscosity influences only the part of a transient optical response.
[0011] On the other hand, in SSFLC, it has spontaneous polarization Ps, and it is changing the amount of transmitted lights by switching the stable state of a liquid crystal molecule by driving force Ps-E by it and electric field E. The speed of response tau at this time is tau** (eta/Ps-E) in approximation.... It will become a formula 1 and will be directly influenced of the rotation viscosity eta. Furthermore, since this rotation viscosity changes a lot to temperature, as for a speed of response tau, it becomes easy to be influenced of temperature. That is, in order to obtain the desired amount of transmitted lights using a transient optical response according to a formula 1 unlike TN mold means of displaying, in SSFLC, it will be directly influenced of viscosity, and it will be sensitive to temperature.
[0012] This technical problem is concerned with the principle of operation of SSFLC. That is, it is very difficult to make the speed of response of SSFLC independent to viscosity. It is also very difficult to make temperature dependence of viscosity small on the other hand. Therefore, in order to realize a component with more small temperature dependence, Factors Ps, i.e., the spontaneous polarization, or electric fields E other than the viscosity eta of a formula 1 must be changed corresponding to the viscosity change by temperature.
[0013] It is comparatively easy to change electric field E with temperature. However, it will become a cost rise -- IC driver with high withstand voltage with which a circuit becomes complicated is needed. Moreover, if the constituent in which spontaneous polarization Ps has the big temperature dependence according to viscosity change is used even when such a change function of electric field E to temperature is added to a component, it is possible to lessen a cost rise. That is, using the big constituent of such temperature dependence of Ps has the advantage which raises the engine performance of the liquid crystal device containing it.

[Translation done.]

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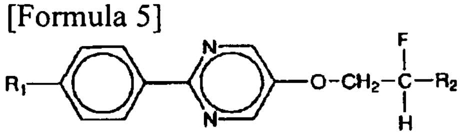
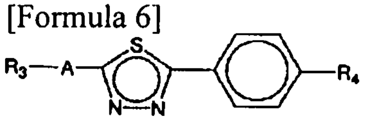
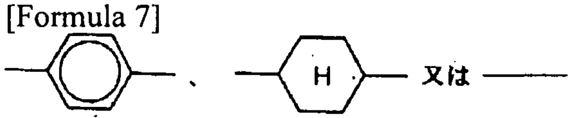
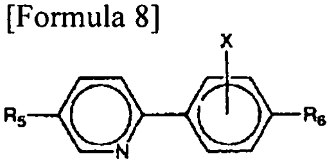
MEANS

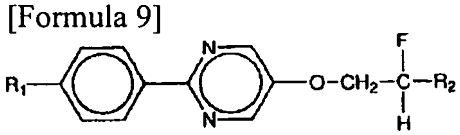
[Means for Solving the Problem] Therefore, the purpose of this invention has the temperature dependence of spontaneous polarization Ps in offering offering a big ferroelectric liquid crystal constituent, the liquid crystal device using this ferroelectric liquid crystal constituent, and its drive approach. According to this invention in this way, it is a general formula (I).
[0015]
[Formula 5]

(I)

[0016] It is [at least one sort and] the following general formula (II) about the ferroelectric liquid crystal compound in which at least two stable states expressed with (R1 shows the alkyl group of carbon numbers 4-16 among a formula, and R2 shows the alkyl group of carbon numbers 2-12, respectively) are shown.
[0017]
[Formula 6]

(II)

[0018] (R3 and R4 show the alkyl group or alkoxy group of carbon numbers 1-15 among a formula, and A is [0019].)
[Formula 7]


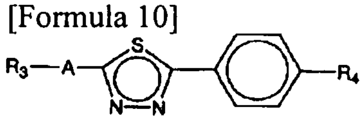
[0020] ****** and a general formula (III) [0021]
[Formula 8]

(III)

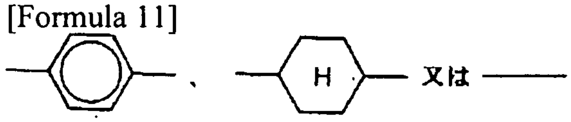
[0022] The ferroelectric liquid crystal constituent characterized by containing at a time at least one sort of compounds made to express with (R5 and R6 show the alkyl group or alkoxy group of carbon numbers 1-18 among a formula, and X shows a hydrogen atom, one piece, or two fluorine atoms) is offered. Furthermore, according to this invention, it is the ferroelectric liquid crystal component which has at least the insulating substrate of the pair equipped with an electrode and the orientation control film in this order, and the liquid crystal layer formed between orientation control film, and the

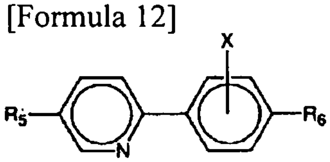
ferroelectric liquid crystal component characterized by a liquid crystal layer containing the above-mentioned ferroelectric liquid crystal constituent is offered.
[0023] Moreover, the insulating substrate of the pair which was equipped with an electrode and the orientation control film in this order according to this invention, The liquid crystal layer which it had between the insulating substrates of this pair, and the driving means which switches the optical axis of liquid crystal by impressing an electrical potential difference to said electrode alternatively, It consists of a ferroelectric liquid crystal constituent containing the ferroelectric liquid crystal molecule which has two stable states even if few. a means to identify the change of said optical axis optically -- having -- said liquid crystal layer -- the above -- Said electrode consists of two or more scan electrodes and two or more signal electrodes, and it arranges in the direction in which a scan electrode and a signal electrode cross mutually. The ferroelectric liquid crystal component which makes a pixel the field where this scan electrode and this signal electrode crossed The 1st pulse voltage V1 is followed to the pixel chosen as arbitration, and they are the 2nd pulse voltage V2 or the 1st pulse voltage. - V1 is followed and it is the 2nd pulse voltage. - V2 is impressed. The ferroelectric liquid crystal molecule contained in the ferroelectric liquid crystal constituent which constitutes said selected pixel is made into one certain stable state of at least two stable states. Subsequently The 1st pulse voltage V3 is followed to said selected pixel, and they are the 2nd pulse voltage V4 or the 1st pulse voltage. - V3 is followed and it is the 2nd pulse voltage. - V4 is impressed. The drive approach of the ferroelectric liquid crystal display device characterized by driving by holding the stable state of said ferroelectric liquid crystal molecule (however, electrical potential differences V1, V2, V3, and V4 having the relation between $0<V2<V4$ and $V2-V1<V4-V3$) is offered.
[0024]
[The mode of implementation of invention] The ferroelectric liquid crystal constituent of this invention is a general formula (I).
[0025]
[Formula 9]

(I)

[0026] At least one sort of ferroelectric liquid crystal compounds expressed with (R1 shows the alkyl group of carbon numbers 4-16 among a formula, and R2 shows the alkyl group of carbon numbers 2-12, respectively) are contained. The compound of a general formula (I) can use each of compound which can use each well-known compound, for example, is indicated by JP,63-190842,A and JP,5-239460,A, and its process for this invention.
[0027] R1 As an alkyl group of carbon numbers 4-16, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, and hexadecyl, methyl, and ethyl, in a side chain is mentioned during a definition. R2 As an alkyl group of carbon numbers 2-12, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, and dodecyl, methyl, and ethyl, in a side chain is mentioned during a definition.
[0028] R1 If it carries out, carbon numbers 6-9 are desirable, and it is R2. If it carries out, carbon numbers 6-8 are desirable. More desirable R1 R2 As a combination, hexyl, hexyl, heptyl and hexyl, octyl and hexyl, nonyl and hexyl, hexyl, octyl, heptyl and octyl, and nonyl and octyl are mentioned. the above -- desirable R1 R2 The phase transition temperature of the compound which it has is shown in Table 1.
[0029]
[Table 1]

化合物番号	R1	R2	Cr	SF*	SC*	SA	I
I−1	$C_6H_{13}-$	$C_6H_{13}-$	· 48.6		· 53.0	· 78.4	·
I−2	$C_7H_{15}-$	$C_6H_{13}-$	· 52.0		· 54.5	· 80.5	·
I−3	$C_8H_{17}-$	$C_6H_{13}-$	· 46.2		(· 45.0)	· 80.0	·
I−4	$C_9H_{19}-$	$C_6H_{13}-$	· 43.6		· 45	· 81.3	·
I−5	$C_6H_{13}-$	$C_8H_{17}-$	· 74.3		· 77.0	· 83.6	·
I−6	$C_7H_{15}-$	$C_8H_{17}-$	· 70.5	(· 59.5)	· 79.4	· 85.4	·
I−7	$C_8H_{17}-$	$C_8H_{17}-$	· 63.5	(· 58.3)	· 76.3	· 84.0	·
I−8	$C_9H_{19}-$	$C_8H_{17}-$	· 60.8	(· 57.4)	· 79.2	· 85.2	·

[0030] In Table 1, the figure expresses phase transition temperature with the Celsius degree, and Cr, SF*, SC*, and SA and I mean each phase of a crystal, chiral smectic one F, chiral smectic one C, smectic A, and an isotropic liquid, respectively. - The mark means that the phase outlined on it exists, and the figure in a parenthesis means that phase transition is monotropy nature.
[0031] Here, the following points are mentioned as a description of the compound of a general formula (I).
(1) The absolute value of spontaneous polarization Ps is large.
(2) The sign of spontaneous polarization changes with temperature.
(3) The temperature from which Ps sign changes is higher than 25 degrees C.
The ferroelectric liquid crystal constituent of this invention is the following general formula (II) as components other than the compound of a general formula (I).
[0032]
[Formula 10]

(II)

[0033] (R3 and R4 show the alkyl group or alkoxy group of carbon numbers 1-15 among a formula, and A is [0034].)
[Formula 11]


[0035] ****** and a general formula (III) [0036]
[Formula 12]

(III)

[0037] Kind content of the compound expressed with (R5 and R6 show the alkyl group or alkoxy group of carbon numbers 1-18 among a formula, and X shows a hydrogen atom, one piece, or two fluorine atoms) is carried out at least. General formula (II) And (III) can use each compound with a well-known compound. R3 And R4 As an alkyl group of carbon numbers 1-15, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, undecyl, dodecyl, tridecyl, tetradecyl, and pentadecyl, methyl, and ethyl, in a side chain is mentioned during a definition.
[0038] R3 And R4 As an alkoxy group of carbon numbers 1-15, the branching-like alkoxy group which

has low-grade alkyl groups, such as a straight chain-like alkoxy group of methoxy and ethoxy ** propoxy, butoxy one, pentoxy, hexyloxy one, heptyloxy, octyloxy, nonyloxy, decyloxy one, undecyloxy, dodecyloxy, tridecyl oxy-** tetra-decyloxy, and PENTADESHIRUOKISHI, methyl, and ethyl, in a side chain is mentioned during a definition.
[0039] R3 If it carries out, the alkyl group or alkoxy group of carbon numbers 3-10 is desirable, and as R4, the alkyl group of carbon numbers 2-8 is desirable. More desirable R3 And R4 As a combination, hexyl, pentyl and octyl, ethyl and butyl, hexyl and butyl, octyl and pentyl, heptyl and pentyl, heptyl and hexyl, octyl and hexyl, pentyl, octyloxy, pentyl and decyloxy one, pentyl and butyl, heptyl and pentyl, and octyl are mentioned.
[0040] Especially desirable A and R3 And R4 As for combination, 1 and 4-cyclo hexylene, hexyl, pentyl, 1, and 4-cyclo hexylene, hexyl, octyl and p-phenylene, octyl, ethyl and p-phenylene, butyl, hexyl and p-phenylene, butyl, heptyl and p-phenylene, butyl, octyl and p-phenylene, pentyl, heptyl and p-phenylene, pentyl, octyl, and p-phenylene, hexyl and octyl are mentioned.
[0041] R5 And R6 As an alkyl group of carbon numbers 1-18, the branching-like alkyl group which has low-grade alkyl groups, such as a straight chain-like alkyl group of methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, DESHIRU, dodecyl, undecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl, methyl, and ethyl, in a side chain is mentioned during a definition.
[0042] R5 And R6 As an alkoxy group of carbon numbers 1-18, the branching-like alkoxy group which has low-grade alkyl groups, such as a straight chain-like alkoxy group of methoxy and ethoxy ** propoxy, butoxy one, pentoxy, hexyloxy one, heptyloxy, octyloxy, nonyloxy, decyloxy one, undecyloxy, dodecyloxy, tridecyl oxy-** tetra-decyloxy, pentadecyl oxy-** hexa decyloxy, hepta-decyloxy, and octadecyloxy, methyl, and ethyl, in a side chain is mentioned during a definition.
[0043] R5 If it carries out, the alkyl group of carbon numbers 6-10 is desirable, and it is R6. If it carries out, the alkoxy group of carbon numbers 4-15 is desirable. More desirable X and R5 And R6 As a combination, a hydrogen atom, heptyl, pentoxy and a hydrogen atom, heptyl, hexyloxy one, a hydrogen atom, octyl, hexyloxy one, etc. are mentioned.
[0044] The blending ratio of coal in the constituent of the above-mentioned general formula (I) - (III) is as following. The orientation rate of the compound of a general formula (I) is 0.5 - 30 % of the weight preferably 0.5 to 60% of the weight in a constituent. In addition, the mixed rate is indicated that the phenomenon in which the sign of spontaneous polarization changes is no longer observed by above-mentioned JP,63-190842,A and JP,5-239460,A at less than 60 % of the weight. In this invention, the following descriptions of (4) were newly found out as a description of the compound of a general formula (I) here in addition to (1) - (3). Furthermore, this description found out that it was discovered even if a mixed rate is less than 60 % of the weight.
(4) The temperature dependence of spontaneous polarization is large.
[0045] Therefore, it can control effectively that the amount of transmitted lights changes with fluctuation of temperature by using the compound of a general formula (I). What is necessary is on the other hand, just to contain in the constituent at least one sort of compounds which general formula (II) Reach (III). In addition, as for both of compounds which general formula (II) Reach (III), containing in the constituent is desirable, and it is more desirable to be contained in a constituent by the weight ratio of 40-90:60-10.
[0046] Here, the ferroelectric liquid crystal constituent of this invention has the following advantageous matters.
(1) A physical-properties value [weight / phase transition temperature / dielectric anisotropy deltaepsilon, viscosity eta, a phase sequence,] is controllable by components other than a compound (I).

(2) Since the pitch in a cholesteric phase becomes short in proportion to the mixed rate of the compound of a general formula (I), if a mixed rate is low, a pitch will become long and its homogeneity stacking tendency in the case of using as SSFLC will improve.
(3) If the mixed rate of the compound of a general formula (I) of spontaneous polarization Ps is high, it will become large. Generally big Ps has the large anti-electric field induction is carried out [electric

field] by the reversal, and the so-called seizure phenomenon becomes severe.
[0047] Therefore, from above-mentioned (1) - (3), the mixed rate of the compound of a general formula (I) of the ferroelectric liquid crystal constituent of this invention is low, and since it has comparatively small Ps, a good ferroelectric liquid crystal component with few printing phenomena can be offered. Furthermore, as for the ferroelectric liquid crystal constituent of this invention, it is desirable that the phase transition sequence is an isotropic liquid phase [from an elevated-temperature side], cholesteric phase, smectic A phase, and chiral smectic C phase. This is because uniform orientation is easy to be obtained in a nematic phase, the orientation which had complete set of direction of the normal of a smectic phase will be obtained easily and a uniform switching characteristic and high contrast will be acquired, if the temperature is lowered from the condition to a smectic A phase and chiral smectic C phase.
[0048] Moreover, it is desirable that deltaepsilon of a constituent is [the absolute value] two or more in negative. When deltaepsilon is forward, since pulse width (tau) falls in monotone as an electrical potential difference (V) becomes high, it is not desirable. Furthermore, when an absolute value is less than two, since it will become a high voltage too much if it is going to obtain a required speed of response, and a speed of response will become slow too much if it is going to lower an electrical potential difference, it is not desirable.
[0049] Furthermore, as for the ferroelectric liquid crystal constituent of this invention, it is desirable to contain at least one sort of optically active compounds whose sense of the spiral produced within a cholesteric phase is opposite sense of the compound of a general formula (I). Thereby, the pitch within a cholesteric phase is compensated and orientation homogeneity improves. Moreover, if the orientation in a cholesteric phase improves, the orientation in a smectic phase will also improve and a uniform switching characteristic and high contrast will be acquired.
[0050] According to this invention, the ferroelectric liquid crystal component which contains the above-mentioned ferroelectric liquid crystal constituent in a liquid crystal layer is also offered. The ferroelectric liquid crystal component of this invention has at least the insulating substrate of the pair equipped with an electrode and the orientation control film in this order, and the liquid crystal layer formed between orientation control film. As an insulating substrate, each thing usually used in the field concerned can be used, for example, glass, plastics, etc. are mentioned.
[0051] the electrode on an insulating substrate -- from metal electrodes, such as transparent electrodes, such as InO_3, SnO_2, and ITO (Indium-TinOxide), and aluminum, Cu, etc. -- becoming -- CVD (Chemical Vapor Deposition) -- it is formed in a predetermined pattern by law or the spatter. The thickness of an electrode has desirable 50-200nm. The orientation control film is formed on an electrode. The film of an inorganic system or an organic system can be used for the orientation control film. Silicon oxide etc. is mentioned as orientation control film of an inorganic system. Although a well-known approach can be used for the membrane formation approach, slanting vacuum deposition, rotation vacuum deposition, etc. can be used, for example. As orientation control film of an organic system, nylon, polyvinyl alcohol, polyimide, etc. are mentioned and rubbing of the front face of the orientation control film is usually carried out. moreover -- the case where a polymer liquid crystal and LB (Langmuir Blodgett) film are used -- a magnetic field -- or orientation may be carried out by the spacer edge method. Moreover, SiO_2, SiN_x, etc. may be formed with vacuum deposition, a spatter, a CVD method, etc., and orientation may be carried out by carrying out rubbing of the it top. The thickness of the orientation control film has desirable 10-100nm. In addition, the following of the concrete orientation approach is carried out.
[0052] The insulating film may be made to intervene between an electrode and the orientation control film here. the insulating film -- for example, SiO_2, SiN_x, aluminum 2O3, and Ta 2O5 etc. -- organic system thin films, such as an inorganic system thin film, polyimide, photoresist resin, and a polymer liquid crystal, can be used. When the insulating film is an inorganic system, it can form by vacuum deposition, the spatter, the CVD method, the solution applying method, etc. moreover, the approach of applying using the solution which melted the organic substance, or its precursor solution by the spinner applying method, the dip painting cloth method, screen printing, a roll coating method, etc. in the case

of an organic system, making harden on predetermined hardening conditions (heating, optical exposure, etc.), and forming or vacuum deposition, a spatter, a CVD method, and LB -- it can also form by law etc. 50-200nm of thickness of the thickness of the insulating film is desirable.

[0053] A ferroelectric liquid crystal component is obtained by pouring a ferroelectric liquid crystal constituent into the space between lamination and the orientation control film for the insulating substrate with which the insulating film was formed in the above-mentioned electrode, the orientation control film, and arbitration through a sealing compound etc., and forming a liquid crystal layer. In addition, the above-mentioned ferroelectric liquid crystal component may be equipped with the polarizing plate as the driving means which changes the optical axis of liquid crystal, and a means to identify the change of said optical axis optically, by impressing an electrical potential difference to the above-mentioned electrode alternatively further.

[0054] The example of the ferroelectric liquid crystal component of this invention is shown in drawing 1 . The transparent insulating substrate (glass substrate) of the pair which has the electrodes 3 and 4 of the predetermined pattern with which 1 and 2 consist of conductive film, the liquid crystal layer between which it is placed between sealing compounds by the orientation control film and 7, and 8 made the insulating film and 6 placed by 5 between the insulating substrate 1 and 2, and 9 show a polarizing plate among drawing 1 . In addition, the driving means which changes the optical axis of liquid crystal is not illustrated by impressing an electrical potential difference to an electrode alternatively.

[0055] As mentioned above, although explained as a switching element with one pixel in drawing 1 , the ferroelectric liquid crystal component of this invention is applicable to the display of a mass matrix. As a display means of a matrix, as shown in the top view of drawing 2 , the approach of using combining the electrodes 3 and 4 of the vertical insulation substrates 1 and 2 the shape of a matrix is mentioned. Each intersection of electrodes 3 and 4 is equivalent to 1 pixel among drawing.

[0056] Drawing 3 is drawing for explaining C1 orientation and C2 orientation in the liquid crystal device of drawing 2 . Here, as an orientation art of the orientation control film which constitutes the ferroelectric liquid crystal component of this invention, the rubbing method is desirable. There are mainly approaches, such as parallel rubbing, antiparallel rubbing, and piece rubbing, in the rubbing method. parallel rubbing -- the vertical orientation control film -- rubbing -- carrying out -- the direction of rubbing -- abbreviation -- it is the parallel rubbing method. Antiparallel rubbing carries out rubbing of the vertical orientation control film, and is the rubbing method the direction of rubbing is substantially antiparallel. Piece rubbing is the approach of carrying out rubbing only of the orientation control film of one side among vertical orientation control film. The most desirable method of obtaining uniform orientation in this invention is the approach of combining the cel processed by parallel rubbing, and the ferroelectric liquid crystal which has an INAC phase sequence. In this case, in a nematic phase, uniform orientation is easy to be obtained, and if the temperature is lowered, the orientation to a smectic A phase and chiral smectic C phase which had complete set of direction of a layer normal will be easily obtained from that condition. However, in the liquid crystal device of parallel rubbing, the number of the orientation conditions produced in a chiral smectic C phase is never one. There are two causes which do not become homogeneity extensively.

[0057] One is related with a smectic layer bending. Although it is known well that the layer structure (Chevron layer structure) to which the ferroelectric liquid crystal cel bent is shown, as shown in drawing 3 , two fields may exist. Kannabe etc. has named these C1 and C2 from relation with a pre tilt. Another is a uniform (U) and the twist (T). The orientation where a uniform shows an extinction position, and the twist are orientation which does not show an extinction position. Kouden etc. has reported that three orientation, C1U (C1 uniform), C1T (C1 twist), and C2, was obtained in the ferroelectric liquid crystal cel of parallel rubbing which used the high pre tilt orientation control film (Jpn.J.Appl.Phys., 30, L1823 (1991)).

[0058] this invention person etc. checked that C1U, C1T, C2U, and four orientation conditions of C2T existed in the ferroelectric liquid crystal cel by which parallel rubbing processing of the orientation control film was carried out, as a result of inquiring in a detail further. The molecular orientation of these orientation conditions is shown in drawing 4 . When compared about four orientation conditions

acquired in the ferroelectric liquid crystal cel which has a negative dielectric anisotropy, since it was hard to switch C1U and C1T orientation, they were difficult to drive, and since there was no extinction position, it turned out that good contrast will not be acquired even if it switches in C1T orientation. On the other hand, it turned out that C2U orientation gives a good switching characteristic and contrast. Moreover, in order that C2T orientation might show quenching nature like uniform orientation at the time of impression of moderate bias electric field when a liquid crystal ingredient has a negative dielectric anisotropy although it does not show quenching nature at the time of no electric-field impressing, this invention person etc. found out that a good SUICHINGU property and contrast were acquired even in C2T orientation.
[0059] Although the appearance nature of C1 and C2 orientation is related to a pre tilt, C2 condition may occur in the range whose pre tilt angle is 0-15 degrees. Although there is only C2 condition of only one condition which shows an extinction position as Kouden etc. has reported when a pre tilt angle is large, this is desirable rather. However, since there is an inclination which becomes easy to turn into C1 orientation from C2 orientation with the increment in a pre tilt angle, a pre tilt angle has desirable 10 degrees or less.
[0060] Next, in this invention, the drive approach of the above-mentioned ferroelectric liquid crystal component is also offered. Hereafter, the drive approach is described. the drive wave shown in drawing 5 as the drive approach, for example -- the JOERS/Alvey driving method by (A), and a drive wave as shown in drawing 6 -- the driving method by (B) is mentioned. These driving methods are the driving methods which can perform partial rewriting, and are desirable methods of driving the ferroelectric liquid crystal component of large display capacity, such as 2000x2000 etc. lines.
[0061] a drive wave -- the wave when not rewriting, although the voltage waveform concerning a pixel is expressed in (B) by (a) - (d) -- tau when the electrical potential difference of (b) and (d) is impressed is equal, and since the amount of transmitted lights is almost equal, the good display without a flicker is obtained. moreover, the drive wave shown in drawing 7 -- the drive wave using the Maine pulse part which is not 0V of 0V part of one time slot, and one time slot as the malvern driving method (the [International Patent Publication] WO 92/02925) which makes (C) an example is shown in drawing 8 -- it is the driving method into which the Maine pulse width was changed by the die length of arbitration to the JOERS/Alvey driving method by (A). Since this driving method can pile up the timing which impresses an electrical potential difference by inter-electrode and can make the Rhine address time small, it is one of the desirable driving methods.
[0062] The method of driving the ferroelectric liquid crystal ingredient of this invention for having the tau-V property which shows the minimal value by pulse width tau including the above-mentioned driving method is characterized at the following points. The method of driving this invention follows the pixel on the selected scan electrode at the 1st pulse voltage V1, and is the 2nd pulse voltage V2 or the 1st pulse voltage. - V1 is followed and it is the 2nd pulse voltage. - By impressing V2, a ferroelectric liquid crystal molecule is not twisted to the stable state before electrical-potential-difference impression, but is made into one stable state with the polarity of applied voltage. Subsequently, the same pixel is followed at the 1st pulse voltage V3, and they are the 2nd pulse voltage V4 or the 1st pulse voltage. - V3 is followed and it is the 2nd pulse voltage. - If V4 is impressed, it will be the driving method for holding the stable state of the ferroelectric liquid crystal molecule before electrical-potential-difference impression. Furthermore, electrical potential differences V1-V4 set to satisfy following type 0<V2<V4V2-V1<V4-V3 to one of the descriptions.
[0063] That is, in two time slots of the selection period beginning, the voltage waveform applied to maintenance has the 2nd pulse voltage higher than the wave applied to rewriting, and a voltage waveform is set up so that the electrical-potential-difference difference of the 1st pulse and the 2nd pulse may become large. Such electrical potential differences V1, V2, V3, and V4 for example, in drive wave (A) of drawing 5 At drive wave (B) of V1=Vd, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd drawing 6 , it becomes V1=Vd, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd by drive wave (C) of V1=0, V2=Vs-Vd, V3=-Vd, and V4=Vs+Vd drawing 7 .
[0064] It sets in the tau-V property of a liquid crystal device, and is minimal value taumin of pulse width

tau. Electrical potential difference Vmin to give It is directly related to the maximum of the electrical potential difference impressed at the time of a drive. The pressure-proofing of a drive circuit used for a drive to Vmin It is Vmin in order to use less than [60V] and the drive circuit using general-purpose IC driver. The ferroelectric liquid crystal constituent which is less than [35V] is needed. Moreover, it sets to the drive of a ferroelectric liquid crystal component whose pulse width tau has the tau-V property which shows the minimal value. By for example, the approach of embellishing component structure like a cel gap or an electrode configuration Use as a wave which applies to maintenance the wave applied to rewriting of the specific part in a pixel by making to arbitration the field where drive properties differ in a pixel in other parts in the same pixel, or It is possible to use as a wave which applies the wave applied to maintenance of the specific part in a pixel to rewriting in other parts in the same pixel. Therefore, a gradation display can also be performed.

[0065] In addition, in explanation of this invention, although parallel rubbing, C2 orientation, the method of driving a property, etc. were described as an example of the directions of very desirable this invention, of course, it cannot be overemphasized that this invention is not limited to this and can apply also to a liquid crystal display another type and the driving method. Next, taumin of this invention The applicability to the used liquid crystal display component is explained. The following formulas are realized by the simple system which assumed layer structure to be book-shelf structure {liquid coulisse TARUZU 6, No.3, and p341 (1989) reference}.

[0066]

[Equation 1]

$$E\min = \frac{Ps}{3^{1/2} \cdot \varepsilon_0 \cdot \Delta\varepsilon \cdot \sin^2\theta}$$

[0067] (Among a formula, in spontaneous polarization and epsilon 0, the dielectric constant of vacuum and deltaepsilon show a dielectric constant anisotropy, and theta shows [an electrical potential difference / in / in Emin / the pulse width of the minimal value /, and Ps] an angle of inclination) Electrical potential difference practical from this formula, for example, Emin, When making it less than [40V], and 20 degrees and deltaepsilon are the liquid crystal constituents of -two and theta uses a 2-micrometer cel, spontaneous polarization is 7 nC/cm2. It must be the following {ferro erection RIKUSU 122nd volume p63 (1991) reference}. Although it is inapplicable as it is since actual layer structure has many which are the Chevron structure, it can use as estimate. It is Emin that this formula shows, so that delta epsilon and theta are so large that Ps is small. It is being able to do low. The pulse width (taumin) of the minimal value is in inverse proportion to the square of spontaneous polarization {ferro erection RIKUSU 122nd volume p63 (1991) reference}. That is, taumin In order to shorten, it is necessary to enlarge spontaneous polarization Ps. if it thinks together with the above-mentioned formula -- Emin low -- for example, less than [40V] -- carrying out -- in addition -- and taumin In order to shorten and to perform a high-speed drive, deltaepsilon needs to have a negative big value. Conversely, it will be Emin if the liquid crystal constituent in which deltaepsilon has a negative big value if it says is used. Even if it sets up low, large Ps is taken, and it is taumin. It can do short. Said compound (II) and compound (III) in this invention are a compound which has big deltaepsilon in negative. Therefore, taumin Application for the used liquid crystal display component is very effective.

[0068] As mentioned above, taumin Although stated focusing on application for the used liquid crystal display component, this invention relates to the manifestation of the big temperature dependence of the spontaneous polarization Ps by the new constituent, and the component using it. That is, the ferroelectric liquid crystal constituent of this invention is taumin a passage clearer than this. Or it is not only adapted for the component using the AC stubbies rise effectiveness, but it can use for the usual SSFLC component.

[Translation done.]

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2.**** shows the word which can not be translated.
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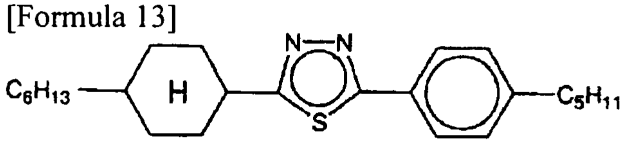
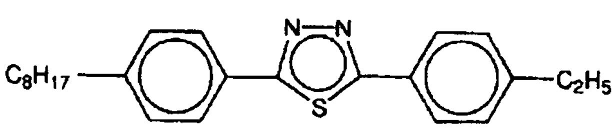
EXAMPLE

[Example] Although an example explains this invention further below at a detail, this invention is not limited to these examples. Measurement of each physical-properties value in this example was performed by the following approach.
Phase transition temperature (degree C): The observation under the polarization microscope which attached the hot stage for temperature control determined. The melting point was measured using differential scan calorimetric analysis (DSC). In the following examples, phase transition temperature (degree C) was indicated between the abridged notations which show a phase. Notations Cr, SX, SC, SA, N, and Iso mean each phase of a crystal, a high order smectic phase, a smectic C phase, a smectic A phase, a nematic phase, and an isotropic liquid, respectively.
[0070] Spontaneous polarization (nC/cm2): The class product was injected into the cel whose electrode spacing which performed orientation processing is 1.5 micrometers, and the polarization reversal current peak was taken out from the current response waveform when impressing a square wave (**15V and 1kHz), and it determined from the area.
A tau-V property, Vmin, taumin : Using the ferroelectric liquid crystal component created by the below-mentioned approach, without impressing bias voltage, two unipolar pulses, forward and negative, were impressed by turns, and it measured by switching domain observation under a polarization microscope. The peak value (V) of this unipolar pulse was changed, by asking for the pulse width (tau) which a domain reverses 100% with each peak value, the tau-V curve was obtained and the peak value (Vmin) in that minimal value and pulse width (taumin) were obtained from this tau-V curve.
[0071] As preparation which produces a ferroelectric liquid crystal constituent, the non-chiral constituent (non-ferroelectricity constituent) as shown below first was produced.
Constituent (a)
[0072]
[Formula 13]



3 5重量%



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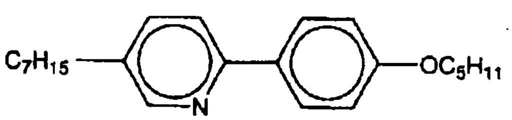
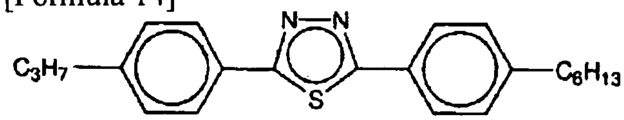


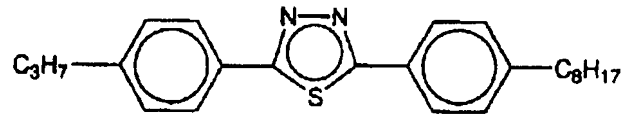
5 0重量%

[0073] The phase transition temperature of this constituent is Cr. -31 degrees C SX -10 degrees C SC

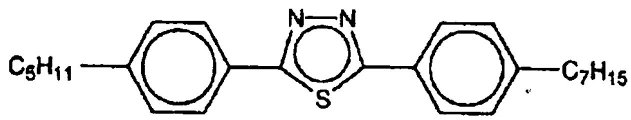
72.8 degrees C SA 85.8 degrees C N 98.1 degrees C It was Iso.
Constituent (b) : [0074]
[Formula 14]



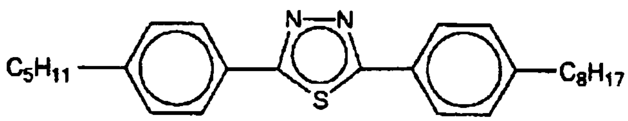
25[illegible]%



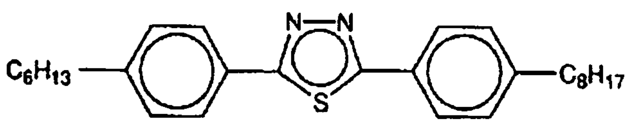
12.5[illegible]%



12.5[illegible]%

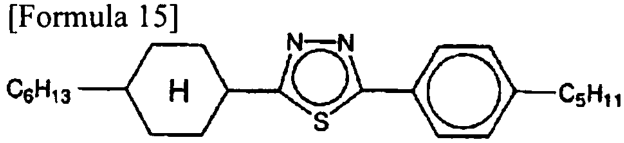


25[illegible]%

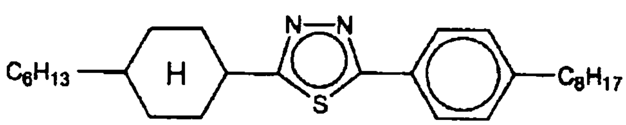


25[illegible]%

[0075] The phase transition temperature of this constituent is Cr. 43 degrees C SC 126.0 degrees C N 154.4 degrees C It was Iso.
Constituent (c) : [0076]
[Formula 15]

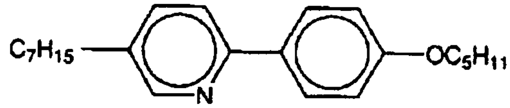


70[illegible]%



30[illegible]%

[0077] The phase transition temperature of this constituent is Cr. 29 degrees C SA 143.7 degrees C N 144.1 degrees C It was Iso.
Constituent (d) : [0078]
[Formula 16]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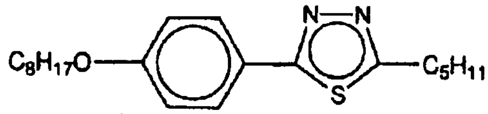
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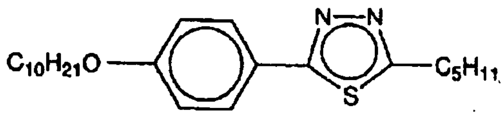
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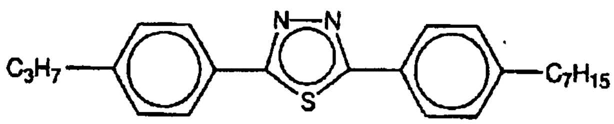
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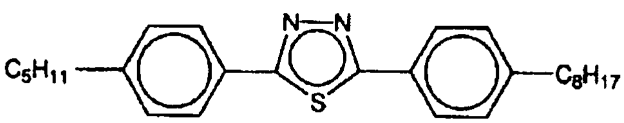
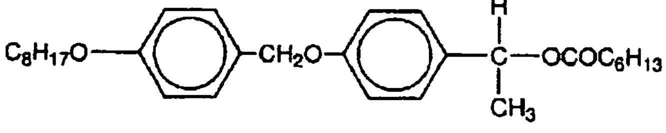

20■■%

[0079] The phase transition temperature of this constituent is Cr. -4 degrees C SC 86.5 degrees C SA 96.8 degrees C N 101.8 degrees C It was Iso.
Constituent (e): Constituent (a) 75-% of the weight constituent (b) 10-% of the weight constituent (c) The phase transition temperature of this constituent is SC 15% of the weight. 74.5 degrees C SA 93.8 degrees C N 107.5 degrees C It was Iso.
[0080] Moreover, in each example, the ferroelectric liquid crystal component was obtained using the approach shown below. That is, the transparent electrode which consists of 200nm ITO was formed on two glass substrates. this transparent electrode top -- 100nm SiO2 from -- the becoming insulator layer was formed, the orientation control film was applied by 50nm of thickness on this insulator layer, and rubbing processing was performed. Next, these two glass substrates were stuck by 1.5 micrometers (gap) of cel thickness so that the direction of rubbing might become parallel. Subsequently, the ferroelectric liquid crystal constituent produced in each example was poured into this gap. The cel was heated after impregnation to the temperature from which a liquid crystal constituent once changes to an isotropic liquid, and the ferroelectric liquid crystal component whose orientation of a liquid crystal molecule is C2 all over the inside of a pixel was obtained by cooling to a room temperature by part for 1-degree-C/after that.
[0081] In the following examples, the compound used as a component of a liquid crystal constituent was displayed with said compound number.
The example 1 aforementioned compound (I-1) and the constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (f) was adjusted.
Compound (I-1) 10-% of the weight constituent (e) ******** of the 90-% of the weight above-mentioned constituent (f) is SC. 57 degrees C SA 94 degrees C N It was 103degree-CI. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 9 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0082] The example 2 aforementioned compound (I-3) and the constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (g) was adjusted.
Compound (I-3) 10-% of the weight constituent (e) The phase transition temperature of the 90-% of the weight above-mentioned constituent (g) is SC. 60 degrees C SA 93 degrees C N 103 degrees C It was I.

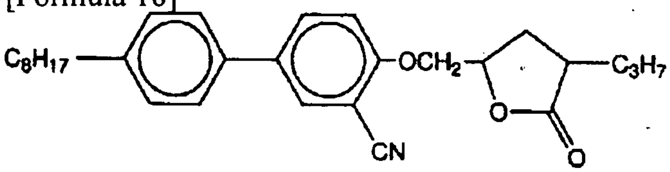
Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 10 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0083] The example 3 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (h) was adjusted.
Compound (I-1) 2.5-% of the weight compound (I-2) 2.5-% of the weight compound (I-3) 2.5-% of the weight compound (I-4) 2.5-% of the weight constituent (e) The phase transition temperature of the 90-% of the weight above-mentioned constituent (h) is SC. 59 degrees C SA 93 degrees C N 102 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 11 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0084] The example 4 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (e) were mixed at following rate, and the ferroelectric liquid crystal constituent (i) was adjusted.
Compound (I-1) 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (e) The phase transition temperature of the 95-% of the weight above-mentioned constituent (i) is SC. 65 degrees C SA 93 degrees C N 104 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 12 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.

[0085] The example 5 aforementioned compound (I-1), (I-2), (I-3), (I-4), and a constituent (d) were mixed at following rate, and the ferroelectric liquid crystal constituent (j) was adjusted.
Compound (I-1) 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (d) The phase transition temperature of the 95-% of the weight above-mentioned constituent (j) is SC. 81 degrees C SA 95 degrees C N 100 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 13 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.

[0086] The example 6 aforementioned compound (I-1), (I-2), (I-3), (I-4), a constituent (a), (b), and (c) were mixed at following rate, and the ferroelectric liquid crystal constituent (j) was adjusted.
It was compound (I-1) I. 1.25-% of the weight compound (I-2) 1.25-% of the weight compound (I-3) 1.25-% of the weight compound (I-4) 1.25-% of the weight constituent (a) 57-% of the weight constituent (b) 19-% of the weight constituent (c) The phase transition temperature of the 19-% of the weight above-mentioned constituent (j) is SC. 73 degrees C SA 99 degrees C N 111 degrees C Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 14 . Spontaneous polarization Ps showed big temperature dependence so that more clearly than drawing.
[0087] Similarly to the pneumatic liquid crystal compound PYP605 by example 7 Merck Co., the optically active compound R-811 by Merck Co. and S-811 were added respectively, and a liquid crystal constituent (l) and (m) were produced to it. It turns out that the sense of the cholesteric pitch of R-811 and S-811 is R (+) and L (-), respectively. A compound (I-1) and (I-3) were independently added to PYP605, respectively, a liquid crystal constituent (n) and (o) were produced, and the sense of a compound (I-1) and each cholesteric pitch of (I-3) was measured by the contacting method using the above-mentioned constituent (l) and (m). Consequently, a compound (I-1) and (I-3) were found by that it is L (-).
[0088] The optically active compound with which it turns out that the sense of an example 8 cholesteric pitch is R (+) (C-1)
[0089]
[Formula 17]



[0090] Said compound (I-1) and constituent (e) were mixed at following rate, and the strong dielectric

forward liquid crystal constituent (p) was prepared.
Compound (C-1) 4-% of the weight compound (I-1) 8-% of the weight constituent (e) The phase transition temperature of the 88-% of the weight above-mentioned constituent (p) is SC. 50 degrees C SA 90 degrees C N It was 98degree-CI. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 15 . Spontaneous polarization ps showed big temperature dependency so that more clearly than drawing.
[0091] Temperature was changed and the tau-V property of the liquid crystal constituent (i) of example 9 example 4 was measured. Pulse width taumin in the minimal value Temperature dependence is shown in drawing 16 . A passage clearer than drawing, it compares with the liquid crystal constituent (q) of the example 2 of the after-mentioned comparison, and is taumin. Temperature dependence became small.
[0092] Example of comparison 1 optically active compound (C-2)
[0093]
[Formula 18]


[0094] Said constituent (e) was mixed at following rate, and the ferroelectric liquid crystal constituent (q) was adjusted.
Compound (C-2) 2.5-% of the weight constituent (e) The phase transition temperature of the 97.5-% of the weight above-mentioned constituent (q) is SC. 66 degrees C SA 92 degrees C N 104 degrees C It was I. Moreover, the temperature dependence of spontaneous polarization Ps is shown in drawing 17 . Drawing shows that the value is saturated with the low temperature side and especially the temperature dependence of the spontaneous polarization of the above-mentioned liquid crystal constituent (q) is small.
[0095] Temperature was changed and the tau-V property of the liquid crystal constituent (q) of the example 1 of example of comparison 2 comparison was measured. Pulse width taumin in the minimal value Temperature dependence is shown in drawing 16 . A passage clearer than drawing, it compares with the liquid crystal constituent (i) of an example 9, and is taumin. Temperature became large. By this invention, the temperature dependence of spontaneous polarization Ps is large, and can obtain the small ferroelectric liquid crystal component of the temperature dependence of a speed of response as the above example and the example of a comparison show.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view of the ferroelectric liquid crystal component of this invention.
[Drawing 2] It is the outline top view of the electrode structure of the ferroelectric liquid crystal component of this invention.
[Drawing 3] It is the approximate account Fig. of C1 orientation of the liquid crystal layer of a ferroelectric liquid crystal component, and C2 orientation.
[Drawing 4] It is the approximate account Fig. of four orientation conditions of the liquid crystal layer of a ferroelectric liquid crystal component.
[Drawing 5] It is the wave-like schematic diagram of the method of driving the ferroelectric liquid crystal component of this invention.
[Drawing 6] It is the wave-like schematic diagram of the method of driving the ferroelectric liquid crystal component of this invention.
[Drawing 7] It is the wave-like schematic diagram of the method of driving the ferroelectric liquid crystal component of this invention.
[Drawing 8] It is the wave-like schematic diagram of the method of driving the ferroelectric liquid crystal component of this invention.
[Drawing 9] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 10] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 11] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 12] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 13] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 14] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 15] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of an example.
[Drawing 16] taumin of the ferroelectric liquid crystal component of an example and the example of a comparison It is drawing showing temperature dependence.
[Drawing 17] It is drawing showing the temperature dependence of the spontaneous polarization Ps of the ferroelectric liquid crystal constituent of the example of a comparison.
[Description of Notations]
1 Two Insulating substrate
3 Four Electrode

5 Insulating Film
6 Orientation Control Film
7 Sealing Compound
8 Liquid Crystal Layer
9 Polarizing Plate

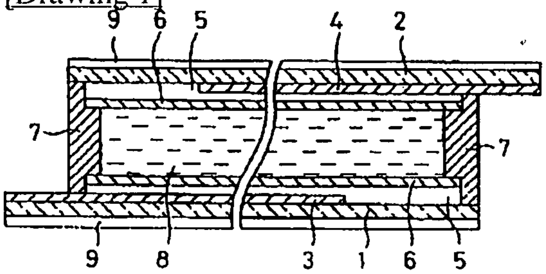
[Translation done.]

* NOTICES *

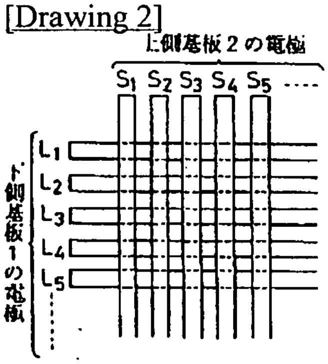
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

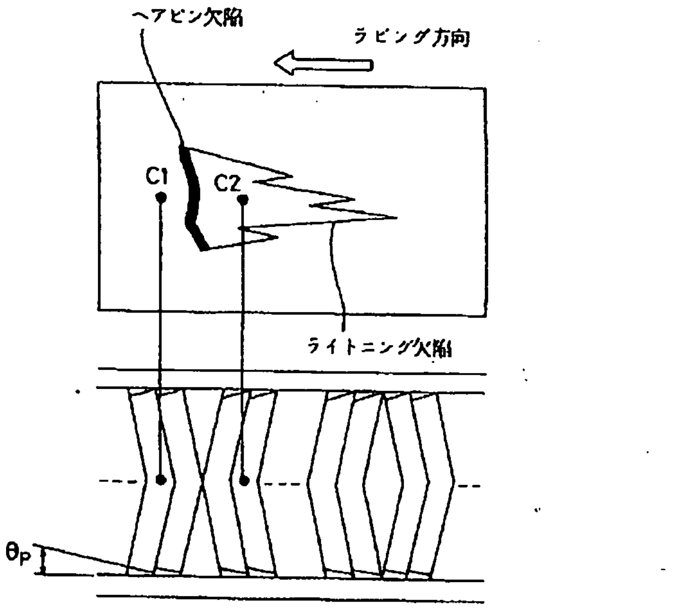
[Drawing 1]



[Drawing 2]



[Drawing 3]



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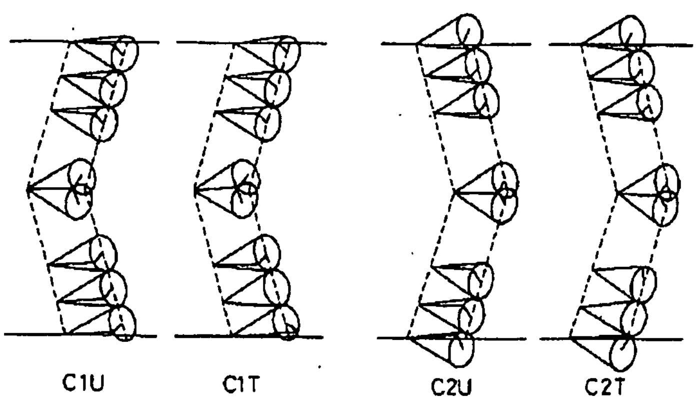

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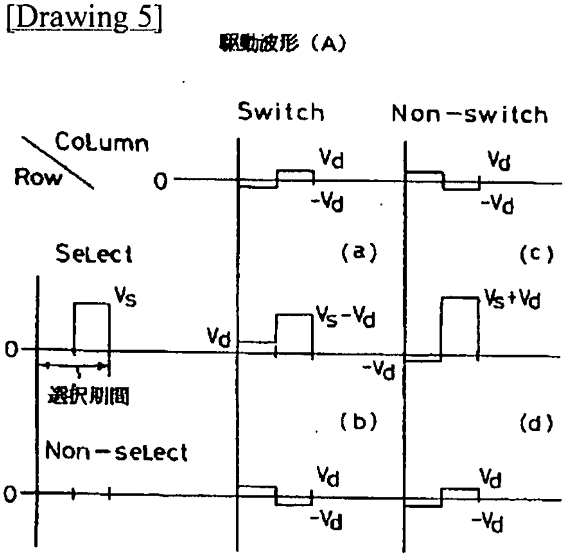

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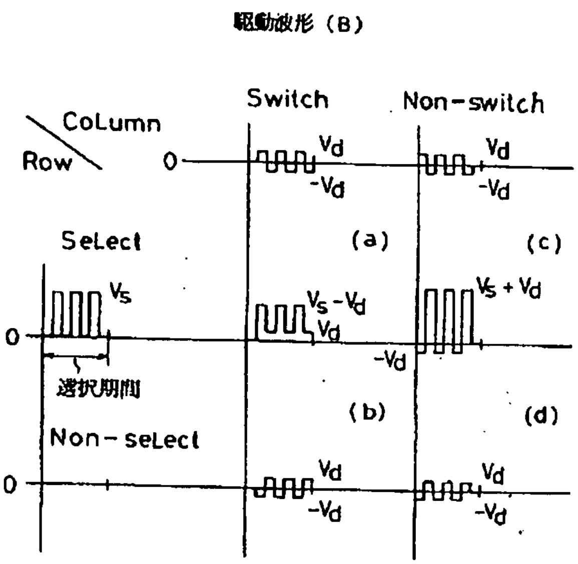
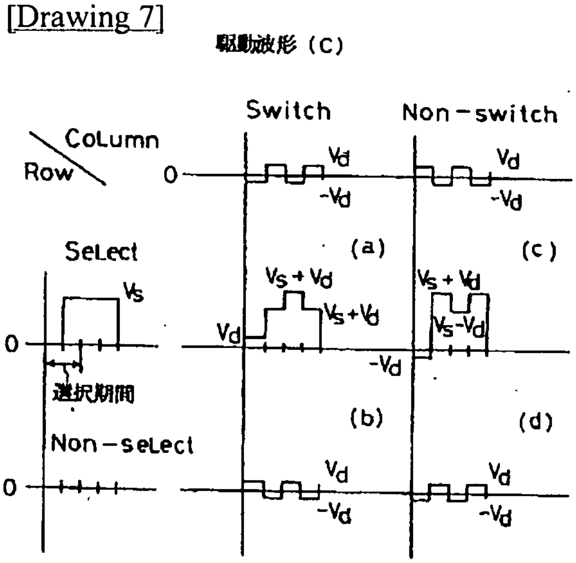


[Drawing 7]



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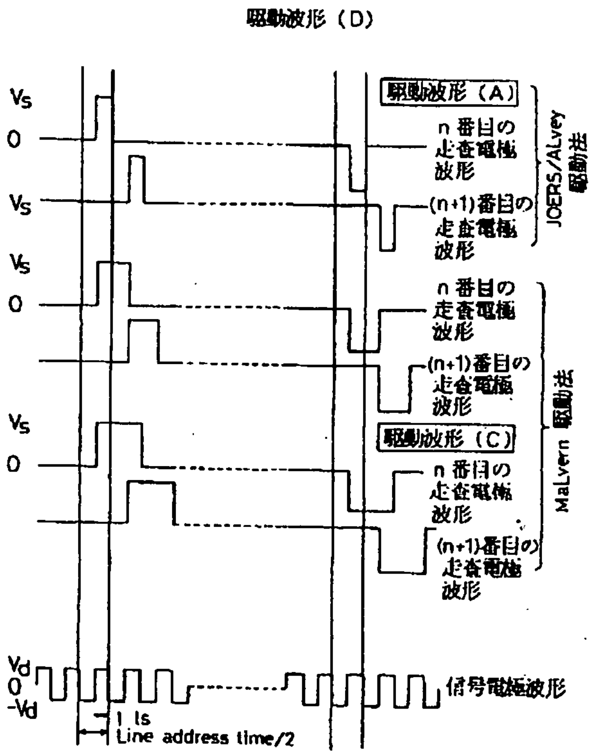

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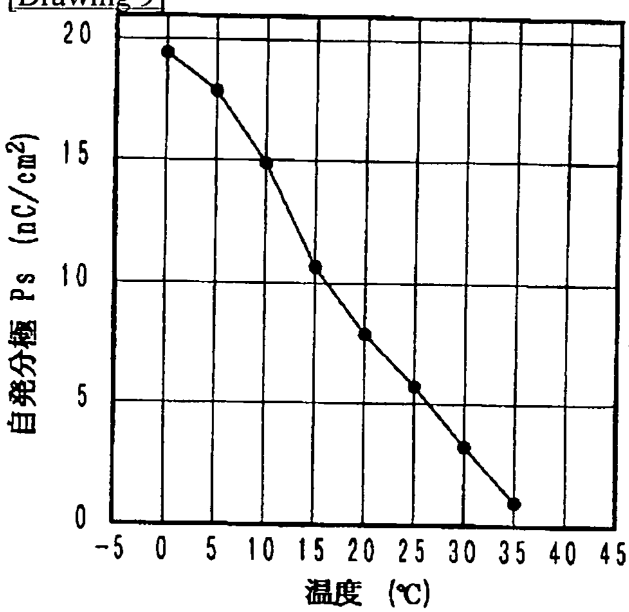

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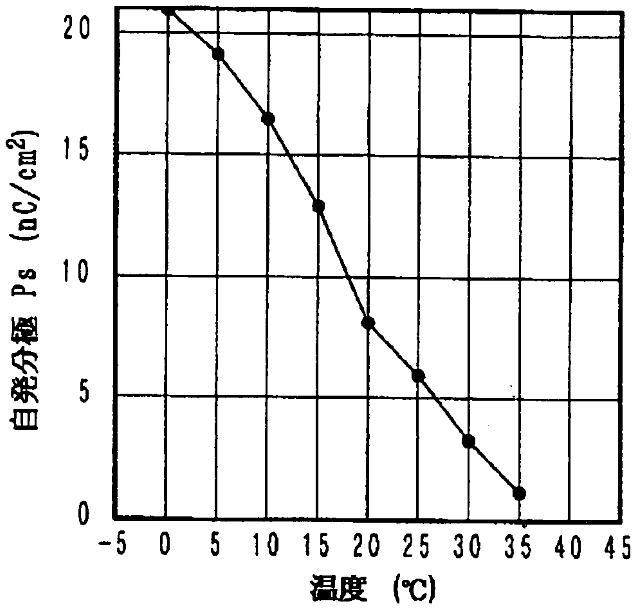

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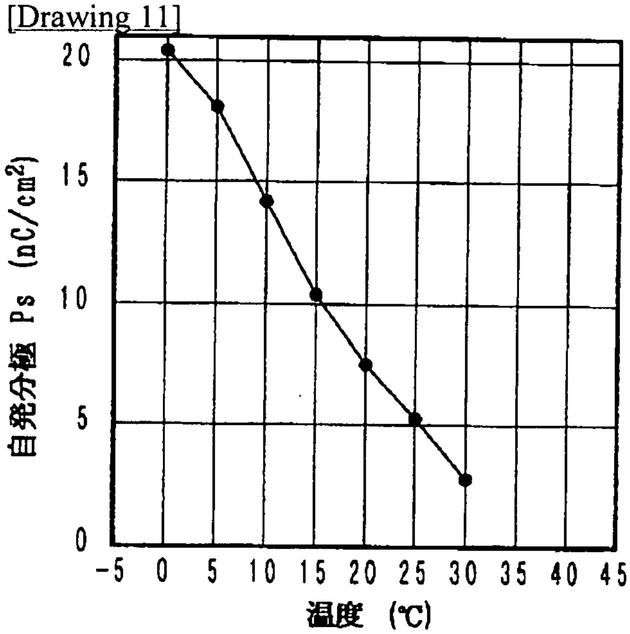

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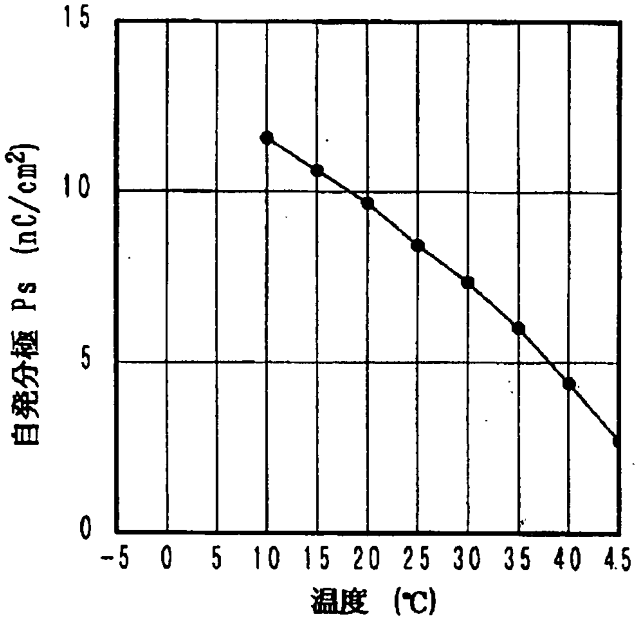

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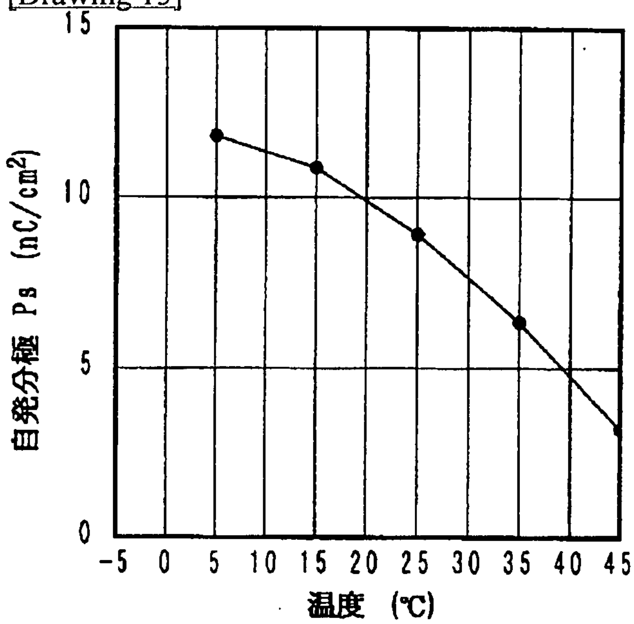

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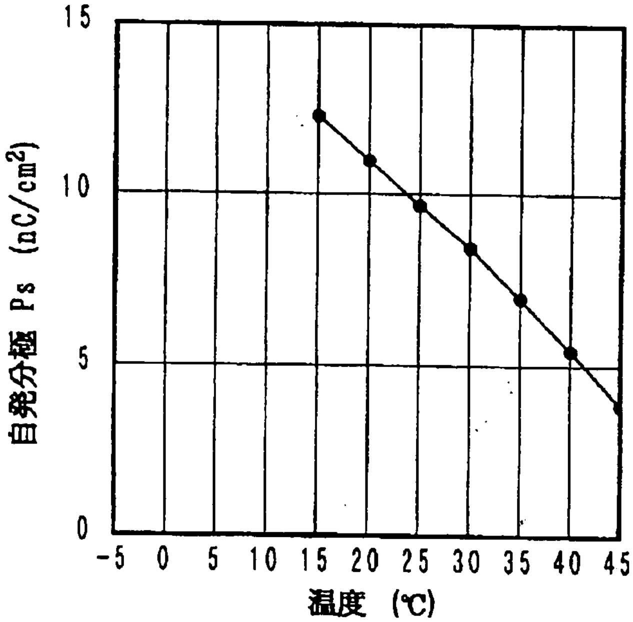

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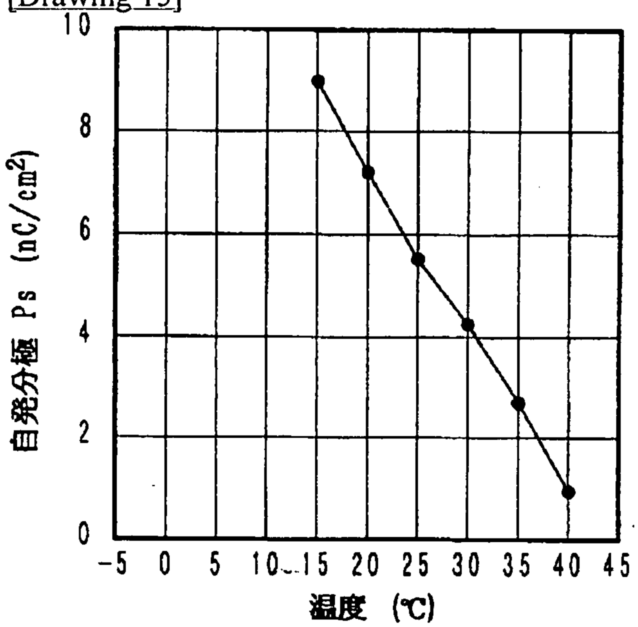
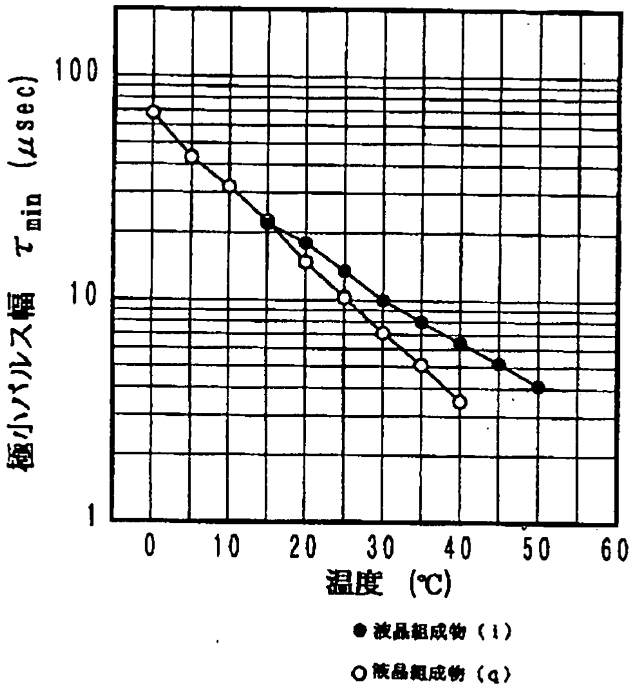
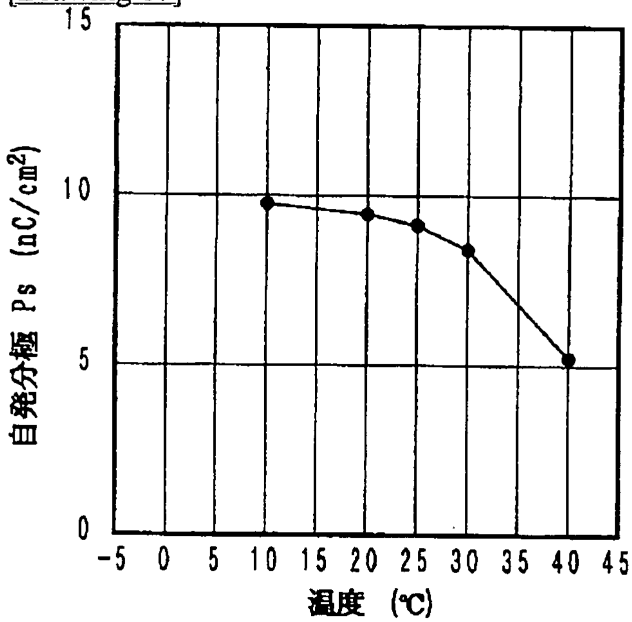


[Drawing 16]



[Drawing 17]



[Translation done.]